



Facultad de Psicología  
Departamento Psicología Básica  
Programa de Doctorado en Psicología

## **TESIS DOCTORAL**

**Integración de las Tecnologías de la Información y de la  
Comunicación (TIC) en contextos educativos: creencias y  
prácticas**

**Integration of Information and Communication Technologies  
(ICT) in educational contexts: beliefs and practices**

### **Autor**

Carlos de Aldama Sánchez

### **Director**

Dr. Juan Ignacio Pozo Municio

Septiembre, 2016

*A mi padre, que ya descansa al otro lado del tiempo,  
y a mi madre, por ser ejemplo de lucha infinita*

Un arcángel asciende del aljibe.  
Un espacio naufraga en el tiempo.  
Mi reloj navega sin manillas.  
Casi un silencio de mirtos y granadas.  
El duende que se filtra por Manhattan  
nos sopla y escapa  
por la celosía de los rascacielos.  
Encuentro la mirada de todas las muchedumbres  
en la larga avenida de las Américas:  
el hombre, los hombres/ las mujeres, son mirada,  
la televisión es mirada, encuentro compartido,  
entendimiento, cauce, plaza común  
donde toda mirada es táctil  
y busca encuentro de la unidad,  
busca el espectador-prójimo en su nostalgia  
sus recuerdos y presentimientos eléctricos,  
su oculto secreto, inaccesible, niño  
a ritmo de intervalos de música infinita.

*“Respiro en Nueva York”, Tientos de Erótica Celeste,*

Val del Omar, 2012

La realización de esta tesis doctoral ha sido posible gracias a una ayuda para la Formación de Personal Investigador otorgada por el Ministerio de Ciencia e Innovación (BES-2011-048314). Dicha ayuda se enmarcó inicialmente en el contexto del proyecto de investigación “Aprendizaje de sistemas externos de representación y cambio representacional en diferentes dominios de conocimiento” (EDU2010-21995-C02-01) y posteriormente en el proyecto de investigación “Hacia un nuevo concepto de alfabetización: el aprendizaje mediante diferentes sistemas externos de representación” (EDU2013-47593-C2-1-P), ambos dirigidos por el Dr. Juan Ignacio Pozo. Parte del trabajo aquí presentado es fruto de la colaboración con la Dra. Sarah Prestridge, de Griffith University, Brisbane, Australia, gracias a la Estancia Breve de la que pude disfrutar durante el año 2013 (EEBB-I-2013-07398). Igualmente, he tenido la oportunidad de colaborar con el Dr. Ruben Vanderlinde y el Dr. Jo Tondeur, de Ghent University, Gante, Bélgica, como parte de una segunda Estancia Breve durante el año 2014 (EEBB-14-BES-2011-048314).

## AGRADECIMIENTOS

---

Contar con un espacio donde poder dar las gracias públicamente es una (preciosa) oportunidad y a la vez un (complicado) reto. Son muchas las personas y tantos los momentos compartidos que me resulta una empresa imposible poder dar fe de todos ellos. Vayan por delante mis disculpas para quiénes sin duda aquí deberían estar pero que por motivos sobre todo de espacio (y de tiempo, tampoco es cuestión de atormentar a la gente) finalmente no incluiré.

En primer lugar quería dar mis gracias más sinceras a Nacho, mi director de tesis. Gracias por la oportunidad que hace ya 5 largos años me ofreciste y por la confianza que has depositado en mí durante todo este tiempo. Allí donde esté, Vygotski estará encantado de ver lo bien que se aplica su noción de Zona de Desarrollo Próximo. Gracias por haber andamiado tan acertadamente este largo proceso personal e intelectual.

Muchas gracias a todos los sujetos y sujetas que tan pacientemente se dejaron examinar. Reconozco plenamente la dificultad que supone abrir las puertas y ventanas de las aulas (y más allá de las aulas) para exponerse ante la mirada de un extraño. Gracias a cada uno de los estudiantes y profesores por hacerme un hueco. Quiero dar las gracias especialmente a Jorge, mi “sujeto experimental” en el estudio de caso. Nunca aprendí tanto en tan poco tiempo, no sólo sobre la integración de las TIC en contextos educativos, sino sobre la relación con los alumnos. Eres un ejemplo perfecto de la mente epistémica que tanto definiendo a lo largo de este trabajo.

Quiero dar las gracias también al equipo de investigación interdisciplinar de la Universidad Autónoma de Madrid sobre el Aprendizaje y cambio educativo por tantos seminarios y discusiones compartidas. Gracias a Elena Martín porque si a alguien le debo mi pasión actual por la Psicología de la Educación, es a ti. Tu inagotable energía y rigurosidad intelectual han sido fuente de inspiración. Gracias a Yolanda y Puy por muchas reflexiones conjuntas, pero sobre todo por el ánimo y aliento. Gracias a Mar Mateos, Isabel Cuevas, Asunción López Manjón y Ruth Campos. Gracias a mis compañeros doctorandos de equipo procedentes de tierras lejanas. A Irón y Rodolfo por aportar miradas diferentes.

Me gustaría dar las gracias también a mis compañeros y compañeras del equipo de sistemas externos de representación y adquisición del conocimiento musical. Aquellos primeros seminarios me enseñaron mucho más que los aspectos formales de la investigación. Gracias especialmente a Alfredo Bautista, Amalia, Guada y Cris (aún recuerdo el tiempo “tan divertido” donde pude comprobar la enorme capacidad del SPADT para no poner en práctica las sugerencias de Norman sobre la psicología de los objetos cotidianos). Gracias a Nora Baccalá por poner algo de orden lexicométrico.

Infinitas gracias a mis compañeros y compañeras del ECIC porque cada encuentro era más rico que el anterior. A Dani, no sé muy bien por dónde empezar. Desde el testafarro en Tarragona, pasando por “in this time”, hasta cada uno de los gestos de trascendencia (véase una buena idea, un plato de cocido o “el refugio” y el vértigo como atracción por el vacío),

gracias. Gracias a Mariana por ser ejemplo de cómo enfrentarse a una tesis. Gracias a Juan Fraile por tantos momentos (por los de investigación, pero sobre todo por los de no investigación). Gracias a Jorge, Mar de la Cueva, Willy, Quique y compañía por cada comentario y sugerencia.

Quiero dar las gracias también a muchos de los profesores e investigadores de la Facultad de Psicología de la Universidad Autónoma de Madrid, sin los cuales seguro que hoy no estaría aquí. Gracias a Nacho Montero por muchas cosas, pero sobre todo por presentarme a Vygotski (sin que yo fuera consciente) cuando me encontraba tan a gusto en el reduccionismo más absoluto. Gracias a Margarita Limón, porque entre encuentros y desencuentros, sin duda me quedo con los primeros. Contigo comencé a dar mis primeros pasos en esto de la investigación, y por ello te estaré siempre agradecido. Gracias a Tino y tu existencialismo radical. Gracias a Mikel por darme todas las facilidades del mundo cuando compartimos docencia en Psicología del Pensamiento. Gracias a Orfelio y tu sincero esfuerzo por allanar el tortuoso camino del doctorando. Gracias por obsesionar a varias generaciones con anacolutos y conectores. Gracias a Luis Carretié por ponerte en nuestra piel. Gracias a Marta Morgade por los contextos formales e informales. Gracias a Ernesto por los momentos compartidos. Gracias a Carmen Nieto, Nieves, Igoa, María Sotillo y Amparo Moreno.

Muchos son los profesores e investigadores procedentes de otras facultades y universidades con los que he tenido la suerte de coincidir. Gracias a María Gil y Alberto Gurrea por aproximarnos con tanta energía e interés a un territorio que os era desconocido. Gracias a Carles Monereo y Toni Badía por vuestros consejos y guía cuando este trabajo apenas era un embrión. Gracias a Inmaculada Arnedillo porque en esta recta final todo han sido facilidades. Thank you very much to Sarah Prestridge for your support and patient. Thank you for give me the opportunity to work with you and let me grow up as researcher. Thank you very much to HDR group of Griffith University in Brisbane, especially to Nat. You were much more than just my host in Uni. Thanks also for your help and patient to deal with my “wonderful” manuscripts written in English (what???). I also want to thanks to my colleges from Ghent University, especially Ruben Vanderlinde and Jo Tondeur. Your critical thinking always pushes me to go further. Thank you very much to my office’s partners, Christian, Sebastiano, Laura and Marcelinho. Thanks for so many laughs sharing “chouffes” (forever and ever spinnekop). Many thanks to Stam and Aneelen because of you my stay in Ghent was a wonderful trip.

Si algo me ha influido y transformado a lo largo de estos años de doctorado ha sido la experiencia vivida y compartida con mis compañeros y compañeras del aula PDIF (en mi cabeza no dejan de resonar las palabras “*somos voces de una misma penuria*”). Nadie mejor que vosotr@s para conocer y reconocer lo que significa este proceso. Gracias a aquella primera generación que me acogió e integró con tanto cariño. A Esther y Andrés por ser puro amor. Gracias a César por hacer tan fácil el comienzo. A Liria por hacer de la distracción una forma de surrealismo. Gracias a Silvia por estar tan cerca a pesar de estar tan lejos. Gracias a Rocío por tu risa contenida y a Helena por mirar las cosas desde otro ángulo. Gracias a Edgar, Isa Carmona, Isa Cabrera, Laura Alonso, Sara, Camino y Angy. ¡¡Godverdomme mañana squash, Manoloquer y Lorereña!! (esto lo escribo un martes cuando espero impaciente que confirméis). Me habéis hecho pensar casi tanto como veces me habéis hecho llorar de la risa. A Jara, por dejarme participar en el juego de tus palabras. Por darte la vuelta y sonreír. Gracias a

Irene por los aspectos formales (revisión del inglés, borradores, etc), pero sobre todo por los informales. Por ser emoción y ternura por igual.

Quiero dar las gracias también a las nuevas generaciones que poco a poco se han ido incorporando y que sin duda me han aportado cosas maravillosas. Gracias a María por comunicar con risas lo que no es capaz de comunicar el lenguaje (el lenguaje o mi sordera, todavía no lo tengo claro). Gracias a Miriam por llevar más tiempo del que crees (sí, en realidad hace muchos años que entraste en el aula). Gracias a Mari Luz por dar fe de tu nombre incluso en el invierno más cerrado. Gracias a Mirtha y tu desbordamiento, gracias a Joana porque “flllllllpias”, gracias a Carlos García y tu serenidad. Gracias Itzi por Madrugada de madrugada y tantas otras cosas (no cometeré el error de tratar de enumerarlas). Gracias a Tamara, Daniel Dorta, Irene Montero y Esther.

Muchas gracias también al PAS de la Facultad de Psicología de la UAM porque sin vosotros no hay nosotros. Gracias a Salu, Pablo(s), Edu, Tomás, Rosa, Violeta y compañía. Gracias por hacerlo todo más fácil. Gracias también a Ruth García por resolver eficazmente cada una de las dudas administrativas con las que te he mareado a lo largo de estos años.

Gracias a mis compañeros y compañeras en la carrera porque ahí se comenzó a forjar todo. Gracias a Ana, Ali, Jaz, Laura, María y Yepes por cada encuentro. Gracias a Miriam por aguantar estoicamente el continuo “run run” de la tesis. Gracias Dina por todo lo compartido.

Quiero dedicar también unas palabras de agradecimiento a aquellas personas que sin estar directamente relacionadas con la investigación y el mundo de la Psicología, han sido claves para poder alcanzar esta meta (y para muchas otras cosas). Gracias sobre todo a mis colegas (en el sentido informal de la palabra) de toda la vida, a Pari, Jolgorio, Burn, Novo, Serg, Javi, Edu, Gon y las últimas incorporaciones, ya no tan recientes, de Peter “Smoke” y Josete alias “Eyyyyy”. A pesar de las enormes diferencias que nos separan, sois oxígeno cuando falta el aire. Gracias por tantos años de buenos y no tan buenos momentos. Gracias Pablo porque mucho antes de compartir piso compartimos experiencias. Gracias a Talía por acompañarme durante más tiempo del que merecía.

Muchas gracias a todos los musicolegas con los que he tenido el placer de compartir local y escenario. A Presos, Mar de Nombres y Lo Bello a lo Bestia. Sin esos momentos, probablemente la tesis habría acabado conmigo antes de yo acabar con ella.

A mi familia se lo debo todo. Gracias Broderini y Lucie por estar siempre ahí. Gracias por engendrar a dos criaturas maravillosas, Pablete y Emilio, que sin saberlo, son infinita inspiración. Gracias por recordarme que la vida sigue siendo un juego. Gracias a mi madre porque nos lo diste todo sin esperar nada a cambio. Gracias por ser ejemplo de tantas cosas. Ninguna frase que pueda articular haría justicia para con cada una de ellas.

Por último, quiero también recordar y agradecer a aquellas personas de las que he tenido que despedirme a lo largo de este camino. Gracias a Miguel Ángel por tu inquietud infinita y por convencerme de que con los pajarillos también se puede aprender física. Gracias Jesús por encarnar como nadie el amor por la música y por compartirlo. Gracias a mi padre por tantos motivos y razones para el recuerdo. Gracias por ser tan radicalmente diferente.

Como no quiero terminar esta sección de forma nostálgica, finalmente quiero dar las gracias a la música por incluir el compás de 4x4, al termostato por dar siempre la temperatura en grados Celsius y sobre todo al reloj, por medir el tiempo segundo a segundo y no primero a primero. Gracias a todos y todas por haberme acompañado en este viaje.



## PUBLICACIONES

---

Esta tesis doctoral se basa en las publicaciones que se referencian a continuación y cuyos textos completos se encuentran incluidos en el presente trabajo:

Prestridge, S. y de Aldama, C. (2016). A classification framework for exploring technology enabled practice-FrameTEP, *Journal of Educational Computing Research*, 1-21  
DOI: 10.1177/0735633116636767

de Aldama, C. y Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, *Electronic Journal of Research in Educational Psychology*, 14 (2), 253-286, DOI: <http://dx.doi.org/10.14204/ejrep.39.15062.pdf>

de Aldama, C., Pérez-García, D. y Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In *SAGE Research Methods Cases*. London, United Kingdom: SAGE Publications, Ltd.

de Aldama, C. y Pozo, J.I. (under revision). Do you want to learn physics? Angry Birds as epistemic tool.

de Aldama, C. y Pozo, J.I. (in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective.

## PUBLICATIONS

---

This doctoral dissertation is based on the following manuscripts. The complete texts are included in the present document:

Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice-FrameTEP, *Journal of Educational Computing Research*, 1-21  
DOI: 10.1177/0735633116636767

de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, *Electronic Journal of Research in Educational Psychology*, 14 (2), 253-286, DOI: <http://dx.doi.org/10.14204/ejrep.39.15062.pdf>

de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In *SAGE Research Methods Cases*. London, United Kingdom: SAGE Publications, Ltd.

de Aldama, C. & Pozo, J.I. (under revision). Do you want to learn physics? Angry Birds as epistemic tool.

de Aldama, C. & Pozo, J.I. (in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective.

Las Tecnologías de la Información y Comunicación (desde ahora en adelante TIC) han transformado radicalmente nuestra forma de ser y estar en el mundo. Desde su irrupción hace ya algunas décadas, nuestra sociedad ha sufrido profundos cambios, modificando sustancialmente las necesidades e intereses de los individuos que la conforman.

La educación formal (ya sean escuelas, universidades u otros centros donde los procesos de enseñanza y aprendizaje son institucionalizados) representa el espacio y el tiempo donde se deben transmitir los saberes y valores socialmente relevantes. Es decir, representa un contexto privilegiado de socialización y enculturación. La influencia de las TIC en estos espacios, sin embargo, se ha limitado en gran parte a transformar los discursos, y en mucha menor medida, las prácticas.

El **objetivo** de la tesis doctoral que se presenta a continuación es *profundizar en el conocimiento sobre el proceso de integración de las TIC como herramientas de enseñanza y aprendizaje en contextos educativos*. Para ello, dos han sido las líneas exploradas. Por un lado, se ha analizado el papel de las *creencias*<sup>1</sup> y *concepciones* del profesorado como factor fundamental a la hora de implementar las TIC de una u otra forma. Los *Estudios I y II*, a partir de los cuales se derivan los *Artículos I y II*, corresponden a esta primera parte. Por otro lado, se han analizado *prácticas* mediadas por TIC consideradas relevantes desde el punto de vista de su integración en contextos educativos. Concretamente, dos han sido las prácticas analizadas. El *Estudio III*, a partir del cual se han elaborado los *Artículos III y IV*, corresponde a un contexto presencial de interacción profesor<sup>2</sup>-alumnos mediado por un entorno digital. El *Estudio IV* es un ejemplo de uso pragmático y epistémico de un videojuego (*Angry Birds*) como instrumento de aprendizaje. El *Artículo V* corresponde a este estudio.

Así, la estructura de esta tesis doctoral se organiza de la siguiente forma. En primer lugar presentamos una introducción teórica compuesta por cinco capítulos. El **Capítulo 1** es un breve recorrido por la relación histórica y evolutiva entre mente y cultura y su proceso de construcción conjunta. La tecnología, entendida en un sentido amplio, sería a la vez expresión cultural y prótesis cognitiva. Entendiendo que este proceso de evolución transforma profundamente la realidad social, llegaríamos al **Capítulo 2**. En él, reflexionamos acerca de los nuevos retos y desafíos educativos del s. XXI para dar respuesta a las demandas de la Sociedad del Conocimiento. Una vez dibujado el escenario, describiremos las diferentes perspectivas en relación con el papel que juegan las TIC como herramientas de enseñanza y aprendizaje y la medida en la que su uso está respondiendo a esas necesidades. Aceptando que un uso transformador pasa por un cambio en la forma en la que percibimos las funciones y finalidades de las TIC, en el **Capítulo 3** se desarrolla una breve conceptualización sobre las creencias y

---

<sup>1</sup> Aunque existen algunos trabajos, sobre todo en el área de matemáticas, donde se diferencia entre creencias y concepciones, asignando a las primeras un mayor valor afectivo y a las segundas un mayor valor conceptual (Ponte, 1999; Thompson, 1992), en la presente tesis doctoral se utilizarán ambos términos indistintamente.

<sup>2</sup> Por una cuestión de economía del lenguaje a lo largo de la tesis emplearé en la mayoría de los casos únicamente el género masculino.

concepciones del profesorado como variable fundamental para llegar a una verdadera integración de las TIC.

En el **Capítulo 4**, partiendo de la idea de que el cambio en la práctica no sólo depende del cambio en las creencias y concepciones, entramos en el aula con el objetivo de describir un espacio privilegiado donde, en último término, se despliegan la gran mayoría de los procesos de enseñanza y aprendizaje en contextos formales. Para ello, identificamos los elementos más relevantes dentro de este contexto, es decir, el profesor, los alumnos y el contenido de aprendizaje (en lo que se ha dado en conocer como “triángulo interactivo”), analizando la naturaleza de sus relaciones para una verdadera integración de las TIC.

Para finalizar este apartado introductorio, en el **Capítulo 5** nos adentramos en una de las líneas con mayor expansión en los últimos años en cuanto a integración de las TIC en contextos educativos, como es el uso de los videojuegos y *serious games* como herramientas de aprendizaje. En este capítulo tratamos de organizar conceptualmente algunos aspectos, que por la rápida expansión de esta área, no se encuentran del todo consensuados, y analizamos especialmente la relación entre estos instrumentos y el aprendizaje en algunos dominios de conocimiento como las ciencias.

Una vez finalizada la introducción se presenta una sección con los objetivos generales de la tesis doctoral y otra con las publicaciones derivadas de este trabajo. Los **Capítulos 6 y 7** corresponden a esta última sección. El *Estudio I*, a partir del cual se publica el *Artículo I*, es fruto de la colaboración con la Dra. Sarah Prestridge, de Griffith University, y la oportunidad que me brindó de participar en el proyecto Serious Play durante los meses que estuve de estancia en Brisbane, Australia, en el año 2013. El trabajo es fundamentalmente una revisión en profundidad de algunos de los constructos considerados más relevantes en el proceso de integración de las TIC en contextos educativos. El objetivo último era diseñar un instrumento de análisis integrador y holístico que permitiera identificar y clasificar creencias y prácticas educativas mediadas por TIC. Para ello se sintetizó información procedente del campo de las creencias epistemológicas, creencias pedagógicas, enfoques pedagógicos, competencia tecnológica y niveles de aprendizaje. El producto final fue la elaboración del *FrameTEP*. Para evaluar la utilidad de esta herramienta se aplicó a tres casos. Los resultados obtenidos mostraron concordancia entre las creencias sostenidas y las prácticas llevadas a cabo.

El *Estudio II*, del cual se deriva el *Artículo II*, continúa explorando la relación entre creencias del profesorado y usos de las TIC, pero desde otro enfoque. En este caso el objetivo también fue el diseño de un instrumento de análisis, pero esta vez con una mirada mucho más analítica. Para ello, nos basamos en el modelo de Resultados, Procesos y Condiciones de Aprendizaje (Pozo, 2008) y evaluamos las creencias y usos de las TIC de una muestra de profesores de primaria. Los resultados encontrados reflejaron una brecha entre las concepciones, más constructivistas y centradas en el alumno, y las prácticas, en general más tradicionales y basadas en el acceso y transmisión de contenidos.

A partir de la idea de que la integración efectiva de las TIC en contextos educativos no sólo depende las creencias epistemológicas y educativas, decidimos desplazarnos hacia el *análisis de prácticas relevantes mediadas por TIC*. Los *Estudios III y IV* (de los cuales se derivan los *Artículos III, IV y V*) responden a este interés.

En este sentido, el *Artículo III*<sup>3</sup> describe las relaciones que se dan entre los elementos del “triángulo interactivo” (profesor, alumnos y contenido de aprendizaje) en un contexto universitario específico donde las TIC fundamentalmente eran utilizadas para el acceso, búsqueda y gestión de la información. Resumidamente, el análisis micro analítico de los *Ciclos Comunicativos* del *Estudio de Caso* observado, reflejó que un contenido más abierto y complejo favorecía interacciones profesor-alumno de mayor riqueza. La complejidad metodológica de este trabajo derivó en el *Artículo IV*, cuyo objetivo fundamental era describir, a través del *Estudio de Caso* mencionado anteriormente, los principios básicos del *Análisis de Contenido* como metodología válida para la investigación educativa.

Por último, en el *Estudio IV* (a partir del cual se deriva el *Artículo V*) se describe otro entorno complejo de enseñanza y aprendizaje mediado por una de las herramientas digitales más populares en la actualidad, como son los videojuegos. Concretamente llevamos a cabo un cuasi experimento (León y Montero, 2105) en diferentes aulas de educación secundaria donde analizamos en qué medida distintas formas de jugar al conocido videojuego Angry Birds permitía o no el aprendizaje de ciertos conceptos relacionados con el movimiento de objetos y el tiro parabólico, contenidos incluidos dentro del currículo de ciencias en educación secundaria. Resumidamente, los resultados reflejaron, aunque con matices, que una práctica guiada por metas epistémicas favorece una comprensión más profunda del fenómeno en cuestión. La Tabla i resume brevemente los trabajos realizados en esta tesis doctoral (para profundizar más ver la SECCIÓN II-OBJETIVOS GENERALES DE LA TESIS)

Finalmente, la tesis concluye con una última sección, compuesta por los **Capítulos 8 y 9**, donde se discuten los resultados obtenidos, así como posibles implicaciones y líneas futuras de investigación.

## Referencias

- León, O. y Montero, I. (2015). *Métodos de investigación en Psicología y Educación. Las tradiciones cuantitativa y cualitativa* [Research methods in Psychology and Education. The quantitative and qualitative traditions] (4<sup>th</sup> ed). Madrid: Mc-Graw-Hill.
- Ponte, J. P. (1999). Teacher's beliefs and conceptions as a fundamental topic in teacher education. En K. Krainer, & F. Goffree, (Eds.), *On research in teacher education: from a study of teaching practices to issues in teacher education* (pp. 43–50). Osnabrück, Deutschland: Forschungsinstitut für Mathematikdidaktik.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Thompson, A. (1992). Teachers' beliefs and conceptions: a synthesis of the research. En D. A. Grouws (Ed.), *International Handbook of Research on Mathematics Teaching and Learning* (pp. 127–146). New York, USA: Macmillan Pub. Com.

---

<sup>3</sup> Este artículo fue parcialmente escrito en colaboración con el Dr. Ruben Vanderlinde y el Dr. Jo Tondeur, de la Universidad de Gante, Bélgica, durante mi estancia breve en 2014.

**Tabla i:** Resumen de los Estudios realizados en la Tesis Doctoral

ÁREA	ESTUDIOS EMPÍRICOS	PUBLICACIONES	RESUMEN OBJETIVOS	RESUMEN RESULTADOS
CONCEPCIONES DE LA PRÁCTICA	ESTUDIO I	<b>Artículo I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	O1.1: Revisión constructos relevantes en relación con las creencias e integración de las TIC en contextos educativos O1.2: Elaboración FrameTEP O1.3: Aplicación FrameTEP	R1.1: Organización teórica R1.2: Integración teórica R1.3: En los tres casos analizados, creencias y usos de las TIC fueron coherentes
	ESTUDIO II	<b>Artículo II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286, DOI: <a href="http://dx.doi.org/10.14204/ejrep.39.15062">http://dx.doi.org/10.14204/ejrep.39.15062</a> . pdf	O2.1: Elaboración Sistema Categorical para el Análisis de las Creencias y Usos de las TIC O2.2: Identificar creencias profesorado O2.3: Identificar prácticas educativas mediadas por TIC O2.4: Identificar algunas variables relevantes relacionadas con las creencias y los usos de las TIC	R2.1: Integración teórica R2.2: Creencias centradas en el alumno R2.3: Usos de las TIC centrados en el contenido y profesor R2.4: Profesores especialistas y de 2º y 3º ciclo de primaria mostraron usos más elaborados
ANÁLISIS DE LA PRÁCTICA	ESTUDIO III	<b>Artículo III</b> de Aldama, C., Pozo, J.I. (in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective	O3: Aportar evidencia empírica en cuanto a la relación de los elementos del triángulo interactivo en un entorno complejo de aprendizaje mediado por TIC	R3.1: El Contenido de Aprendizaje influye en gran medida en la calidad de la interacción entre docente y estudiantes R3.2: La calidad de la interacción también depende de la capacidad del docente para redefinir las preguntas de los alumnos en otras más complejas
		<b>Artículo IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in	O4: Describir principios básicos del <i>Análisis de Contenido</i> como método	R4: Elaboración de un material útil para aplicar el <i>Análisis de Contenido</i> como

		press). Analysis of content: ICT Integration in higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd	de investigación en Educación	método de investigación en Educación
	ESTUDIO IV	<b>Artículo V</b> de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool	O5.1: Aportar evidencia empírica en cuanto al aprendizaje de conceptos sobre el movimiento de objetos, fruto del uso pragmático y epistémico del Angry Birds O5.2: Efecto del uso del Angry Birds sobre “creencias ingenuas” en relación con el movimiento de objetos (p.ej: “speed-mass belief”) O5.3: Efecto sobre el aprendizaje del uso individual o por parejas del Angry Birds	R5.1: El mero hecho de jugar al <i>Angry Birds</i> no produce aprendizaje significativo. El aprendizaje se produce cuando la práctica es guiada por metas epistémicas R5.2: El uso del Angry Birds no tuvo efecto sobre “creencias ingenuas” como el efecto de la masa en la caída libre de objetos R5.3: No hubo diferencias significativas entre los que jugaron individualmente o por parejas

Information and Communication Technologies (ICT from now on) have radically transformed our way of being in the world. For some decades, our society has suffered deep changes, modifying necessities and interests of individuals.

Formal education (either schools, universities or other similar institutions) represents the space and time where socially relevant knowledge has to be transmitted. The influence of ICT in these spaces, however, has been limited to transform discourses and, to a much lesser extent, practices.

The **aim** of the doctoral dissertation is to *provide knowledge about the process of ICT integration as teaching and learning tools in educational contexts*. To do this, two research lines have been explored. On the one hand, we have analyzed the role of teachers' conceptions and beliefs as a key factor in the implementation of ICT. *Manuscripts I and II*, based on *Studies I and II*, belong to this part. On the other hand, we have analyzed relevant *practices* mediated by ICT. Specifically, two practices have been analyzed. *Study III* corresponds to the first one and *Manuscripts III and IV* are derived from it. Briefly, it is based on a face-to-face context where teacher and students interact mediated by a digital environment. The second practice corresponds to the *Study IV*, and *Manuscript V* is derived from it. In this regard, this study is an example of the pragmatic and epistemic use of a videogame (*Angry Birds*) as a learning instrument.

Thus, the structure of the doctoral dissertation is as follows. The first section, consisting of five chapters, provides the theoretical background. **Chapter 1** is a brief walk around the historic and evolutionary relationship between mind and culture. Technology, in a broad sense, would be at the same time cultural manifestation and cognitive support. This process transforms deeply the social reality.

In **Chapter 2**, we reflect on the new educational challenges in XXI century to respond appropriately to those transformations. After drawing a general view, we describe the different perspectives in regard to the role of ICT in education. Accepting that the way we use ICT largely depends on our conceptions and beliefs, in **Chapter 3** we briefly develop a theoretical conceptualization about them as key factors to achieve a true integration of ICT.

In **Chapter 4** the aim is to go further and describe the new roles and functions of the three main elements in any teaching and learning context, (teacher, students and content of learning, what is called "the interactive triangle"), where their actions are mediated by ICT.

Finally, in **Chapter 5** we explore one of the most popular research lines in recent years concerning ICT integration in educational contexts, such as the use of videogames and *serious games* as learning tools. Through this chapter I try to organize conceptually some aspects that, due to the fast expansion of this area, are still a subject of discussion. In addition, I analyze the relationship between these instruments and learning, especially in knowledge domains like sciences.



After the theoretical section, we present the general aims of the doctoral dissertation and the manuscripts derived from it. **Chapters 6 and 7** are included in this section. The *Study I* (from which *Manuscript I* is written) is part of the collaboration with Dr. Sarah Prestridge, from Griffith University, and the opportunity she gave me to participate in the Serious Play Project during my stay in Brisbane, Australia, in 2013. This work is basically a deep review of some key factors related with the process of ICT integration. The main aim was to design a holistic tool of analysis that let us identify and classify teachers' beliefs and practices mediated by ICT. Doing so, we synthesized information about epistemological beliefs, pedagogical beliefs, pedagogical approaches, technological competency and level of learnings. The final product was the elaboration of *FrameTEP*. We proved it applying with three cases. Results showed that beliefs and practices were aligned.

The *Study II* (from which *Manuscript II* was written) continues to explore the relationship between teachers' beliefs and practices, but from another approach. In this case the aim was also the design of another tool of analysis, but now with a much more analytical view. To do this, we based on Results, Processes and Conditions of Learning Model (Pozo, 2008) and assessed beliefs and uses of ICT applying it to a primary teachers' sample. The findings showed an important gap between beliefs and practice. While the former were more constructivist and student-centered, the latter were more traditionalist and based on access and transmission of content.

Based on the idea that effective integration of ICT in educational contexts is not just a matter of beliefs, we decided to move on towards the *analysis of relevant practices mediated by ICT*. *Study III* (from which *Manuscript III* and *IV* were written<sup>1</sup>) describe the relationship between elements of "the interactive triangle" (teacher, students and content of learning) in a specific learning context where ICT were basically used for access, searching and management of information. Briefly, the micro analysis of *Communication Cycles* of the case study observed showed that the more open the content was, the more fruitful teacher-student interaction was. The methodological complexity of this work derived in the *Manuscript IV*, where the main goal was to describe the basic principles of *Content Analysis* as a valid method for educational research.

Finally, in *Study IV* (from which *Manuscript V* is written) we describe another complex learning environment, in this case mediated by a videogame. Specifically, we conducted a quasi-experiment (León y Montero, 2015) where we analyzed to what extent different uses of the well-known videogame *Angry Birds* enhanced learning of concepts about objects motion. The results reflected that learning is produced when the practice is guided by epistemic goals. Table ii summarizes the works conducted in this doctoral dissertation (for more details see SECTION II-GENERAL AIMS).

The document finishes with a last section, compounded by the **Chapters 8 and 9**, where we discuss the results obtained and possible future lines of research.

---

<sup>1</sup> This manuscript was partially written in collaboration with Dr. Ruben Vanderlinde and Dr. Jo Tondeur, from Ghent University, Belgium, during my stay in 2014.

## References

- León, O. & Montero, I. (2015). *Métodos de investigación en Psicología y Educación. Las tradiciones cuantitativa y cualitativa* [Research methods in Psychology and Education. The quantitative and qualitative traditions] (4<sup>th</sup> ed). Madrid: Mc-Graw-Hill.
- Ponte, J. P. (1999). Teacher's beliefs and conceptions as a fundamental topic in teacher education. En K. Krainer, & F. Goffree, (Eds.), *On research in teacher education: from a study of teaching practices to issues in teacher education* (pp. 43–50). Osnabrück, Deutschland: Forschungsintitut für Mathematikdidaktik.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Thompson, A. (1992). Teachers' beliefs and conceptions: a synthesis of the research. En D. A. Grouws (Ed.), *International Handbook of Research on Mathematics Teaching and Learning* (pp. 127–146). New York, USA: Macmillan Pub. Com.

**Table ii. Summary of Doctoral Dissertation Studies**

AREA	EMPIRICAL STUDIES	PUBLICATIONS	SUMMARY OF AIMS	SUMMARY OF RESULTS
CONCEPTIONS AND USES OF ICT	STUDY I	<b>Manuscript I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	A1.1: Review of main constructs related with beliefs and uses of ICT A1.2: Elaboration of FrameTEP A1.3: Application of FrameTEP	R1.1: Theoretical organization R1.2: Theoretical integration R1.3: In the three cases analysed, beliefs and uses were coherent
	STUDY II	<b>Manuscript II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286, DOI: <a href="http://dx.doi.org/10.14204/ejrep.39.15062.pdf">http://dx.doi.org/10.14204/ejrep.39.15062.pdf</a>	A2.1: Elaboration of Categorical System for Analysis of Beliefs and Uses of ICT A2.2: Identify teacher beliefs A2.3: Identify teacher practices mediated by ICT A2.4: Identify some relevant variables related with beliefs and uses of ICT	R2.1: Theoretical integration R2.2: Student-centred beliefs R2.3: Teacher and content-centred practice R2.4: Specialist teachers and 2 <sup>nd</sup> and 3 <sup>rd</sup> primary cycle teachers showed more sophisticated uses
ANALYSIS OF PRACTICE MEDIATED BY ICT	STUDY III	<b>Manuscript III</b> de Aldama, C., Pozo, J.I. (in preparation) ICT as teaching and learning tools at university: A case study from a relational perspective	A3: Provide empirical evidence about the relationship between elements of <i>interactive triangle</i> when their actions are mediated by ICT	R3.1: The Learning Content has a great influence in the quality of interaction between teacher and students R3.2: The quality of interactions also depends on the capability of the teacher to redefine the students' questions in other more complex
		<b>Manuscript IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in	A4: Describe basic principles of <i>Content Analysis</i> as research method in education	R4: Elaboration of useful material for application <i>Content Analysis</i> as research method in education

		higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd		
	STUDY IV	<b>Manuscript V</b> de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool	A5.1: Provide empirical evidence concerning learning about object motion through use of <i>Angry Birds</i> A5.2: How use of Angry Birds affects “naïve conceptions” related with object motion (p.ej: “speed-mass belief”) A5.3: How use Angry Birds individually or per pairs affects learning about object motions	R5.1: Use Angry Birds guided by pragmatic goals did not produce relevant learning. Learning enhanced when practice was guided by epistemic goals R5.2: Use of Angry Birds did not have any effect on “naïve conceptions” R5.3: There were not significant differences between those who played individually or per pairs.

<b>Agradecimientos</b> .....	i
<b>Publicaciones</b> .....	v
<b>Publications</b> .....	viii
<b>Resumen tesis doctoral</b> .....	ix
<b>Abstract doctoral dissertation</b> .....	xv
<b>SECCIÓN I: ANTECEDENTES TEÓRICOS</b> .....	1
<b>Capítulo 1. TIC, Cultura, Sociedad y desarrollo cognitivo: una mirada evolutiva</b> .....	5
1.1. Tecnología, cultura y desarrollo cognitivo: un breve recorrido por la historia.....	5
1.2. De la cultura episódica a la cultura virtual .....	7
1.3. De la Sociedad de la Información a la Sociedad del Conocimiento .....	9
Referencias.....	11
<b>Capítulo 2. TIC, Educación y Aprendizaje en el s. XXI</b> .....	15
2.1. Nuevos retos y desafíos en la Educación del s.XXI: “ser (competente) o no ser, esa es la cuestión” .....	16
2.2. ¿Responden las TIC a las demandas de la Educación del s.XXI? .....	19
2.2.1. <i>El argumento optimista: las TIC como herramientas de transformación</i> .....	20
2.2.2. <i>El argumento pesimista: las TIC y el empobrecimiento de los procesos de enseñanza y aprendizaje</i> .....	21
2.2.3. <i>El argumento escéptico: sin rastro del cambio</i> .....	21
2.2.4. <i>Entonces...¿pueden las TIC responder a los desafíos de la Educación del s. XXI? .....</i>	22
Referencias.....	24
<b>Capítulo 3. Concepciones y Teorías Implícitas: allanando el terreno para una integración de las TIC en el aula</b> .....	29
3.1. Teorías implícitas: principios epistemológicos, ontológicos y conceptuales .....	29
3.2. Concepciones y teorías implícitas en relación con el uso educativo de las TIC .....	31
Referencias.....	32
<b>Capítulo 4. las TIC en la práctica: hacia una mediación de los elementos del triángulo interactivo</b> .....	35
3.1. El alumno en el s. XXI .....	35
3.2. El profesor en el s. XXI.....	37
3.3. El contenido de aprendizaje en el s. XXI.....	38
Referencias.....	39

<b>Capítulo 5. Videojuegos y <i>Serious Games</i> como ejemplo de integración educativa de las TIC</b>	41
5.1. Videojuegos y <i>serious games</i> como herramientas de aprendizaje: un breve recorrido por la historia	41
5.2. ¿Por qué los videojuegos para el aprendizaje de las Ciencias?	44
5.3. Uso de los videojuegos para el desarrollo de una mente epistémica	45
Referencias	46
<b>SECCIÓN II: OBJETIVOS GENERALES</b>	51
<b>SECTION II: GENERAL AIMS</b>	57
<b>SECCIÓN III: ESTUDIOS EMPÍRICOS</b>	63
<b>Capítulo 6: Concepciones del profesorado e integración de las TIC en contextos educativos (Estudios I y II).</b>	65
<b><i>Estudio I-Artículo I</i></b>	
Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice-FrameTEP, <i>Journal of Educational Computing Research</i>	67
Abstract	69
Background	69
Building a Classification Framework for Technology-Enabled Practice	71
Teacher epistemic beliefs	71
Teacher's Pedagogical Beliefs About ICT	72
Teacher Pedagogical Practices With ICT	74
Levels of Learning With ICT	75
A Classification Framework for Technology-Enabled Practice	76
Application of FrameTEP	77
Case Study 1: Lucy	77
Case Study 2: Judy	78
Case Study 3: Janet	79
Discussion and Conclusions	80
Limitations and Future Research	82
Acknowledgements	82
Declaration of Conflicting Interests	82
Funding	82
References	83
Author Biographies	85

## **Estudio II-Artículo II**

de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> .....	87
Abstract .....	89
Resumen .....	90
Introduction .....	91
Educational beliefs held by teachers.....	91
Uses of ICT in the classroom .....	92
Teachers' educational beliefs and how they relate to the use of ICT in the classroom .....	93
Study aims .....	95
Method.....	95
Participants.....	95
Instrument for data collection .....	95
Procedure .....	96
Data analysis.....	96
Classification of teachers' educational beliefs and use of ICT .....	101
Results .....	101
Teachers' educational beliefs.....	101
Teachers' uses of ICT .....	102
Conclusions about teachers' educational beliefs and uses of ICT .....	103
Teachers' educational beliefs according to subjects taught.....	103
Teachers' use of ICT according to subjects taught.....	104
Conclusions about teachers' educational beliefs and uses of ICT according to subjects taught .....	105
Teachers' educational beliefs according to educational stage .....	105
Teachers' use of ICT according to educational stage .....	106
Conclusions about teachers' educational beliefs and uses of ICT according to educational stage .....	107
Discussion.....	108
Acknowledgement .....	109
References.....	110

**Capítulo 7: Análisis de la práctica e integración de las TIC en contextos educativos (Estudios III y IV) ..... 115**

***Estudio III-Artículo III***

de Aldama, C., Pozo, J.I (unpublished manuscript). ICT as teaching and learning tools at university: A case study from a relational perspective .....	117
Abstract .....	119
Introduction .....	119
Background .....	120
Teacher, students and learning content: an interactive ICT-mediated triangle in the new learning culture. ....	120
Learning and processing levels.....	121
Method.....	123
Participants.....	123
Procedure .....	124
Analysis.....	125
Classroom Activity Structure.....	126
Results .....	129
Activities chosen by students.....	129
ICT Uses required by Activities according to Information Management. ....	129
ICT uses required by the Activities according to Materials Production. ....	130
Distribution of Student Demand according to Activities chosen. ....	131
Cognitive Demand of Student Request according to Activities Chosen .....	132
Teacher's Pedagogical Assistance according to Student Request .....	133
Teacher's Pedagogical Assistance according to Activity chosen by Student. ....	133
Cognitive Demand of Teacher's Pedagogical Assistance according to Activities chosen by Students .....	134
Interaction: Structure of Participation .....	135
Interaction: Level of Participation.....	136
Interaction: Degree of Cycle Aperture (Initial-Final).....	137
Conclusions and Discussion.....	139
Limitations of the study and future lines of research .....	140
Acknowledgement .....	140
References.....	140



### ***Estudio III-Artículo IV***

de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In *SAGE Research Methods Cases*. London, United Kingdom: SAGE

Publications, Ltd .....	143
Abstract .....	145
Learning Outcomes .....	145
Case Study .....	145
Project Overview and Context: Integration of ICT in formal education as learning tool..	145
Research Design .....	146
Research Practicalities.....	147
Analysis of content in action .....	149
Practical Lessons Learned .....	154
Conclusions .....	155
Acknowledgement. ....	156
Exercises and Discussion Questions.....	156
Further Readings .....	156
Web Resources.....	156
References.....	156
Contributor Biographies.....	158

### ***Estudio IV-Artículo V***

de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool .....

Abstract .....	161
Introduction .....	161
Videogames and learning science and physics .....	162
Angry Birds and learning about motion .....	163
Collaborative learning through use of videogames .....	164
Research questions .....	165
Method.....	165
Sample.....	165
Procedure .....	166
<i>Week 1: Pre Phase</i> .....	166
<i>Week 2: Traditional theoretical instruction and experimental phase</i> .....	168
<i>Week 3: Post Phase</i> .....	168
Data analysis.....	169

Results .....	170
Analysis of answers to questionnaire .....	170
Analysis of explanations on how to throw a stone .....	172
Conclusions .....	173
Limitations and future research .....	174
Acknowledgment. ....	175
References.....	175
<b>SECCIÓN IV: DISCUSIÓN GENERAL Y CONCLUSIONES FINALES .....</b>	<b>179</b>
<b>Capítulo 8. Discusión general.....</b>	<b>181</b>
8.1. Concepciones del profesorado e integración de las TIC en contextos educativos .....	181
<i>Estudio I: Clasificación y análisis de las creencias y usos de las TIC: Elaboración del FrameTEP .....</i>	<i>181</i>
<i>Estudio II: Clasificación y análisis de las creencias y usos de las TIC: Elaboración de un Sistema Categorial .....</i>	<i>182</i>
8.2. Análisis de la práctica e integración de las TIC en contextos educativos.....	183
<i>Estudio III: Integración de las TIC en el aula: Un Estudio de Caso .....</i>	<i>183</i>
<i>Estudio IV: Aprendizaje de conceptos sobre el movimiento de los objetos a través del uso (epistémico) del Angry Birds.....</i>	<i>184</i>
Limitaciones y líneas futuras de investigación .....	191
Referencias.....	194
<b>Chapter 8.General Discussion .....</b>	<b>197</b>
8.1. Teachers' conceptions and integration of ICT in educational contexts .....	197
<i>Study I: Classification and analysis of beliefs and uses of ICT: Elaboration of FrameTEP .</i>	<i>197</i>
<i>Study II: Classification and analysis of beliefs and uses of ICT: Elaboration of System of Categories.....</i>	<i>197</i>
8.2. Analysis of practice and integration of ICT in educational contexts .....	198
<i>Study III: Integration of ICT in classroom: A case study.....</i>	<i>198</i>
<i>Study IV: Learning concepts about object motion through (epistemic) use of Angry Birds .....</i>	<i>199</i>
Limitations and future research .....	203
Referencias.....	207
<b>Capítulo 9. Conclusiones finales.....</b>	<b>209</b>
Referencias.....	210
<b>Chapter 9. Final conclusions.....</b>	<b>211</b>
References .....	212

<b>SECCIÓN V: ANEXOS</b> .....	213
<b>ANEXO A-Estudio I</b> .....	215
<i>ANEXO A1-Portada original artículo (Artículo I)</i> .....	215
<b>ANEXO B-Estudio II</b> .....	217
<i>ANEXO B1-Portada Original Artículo (Artículo II)</i> .....	217
<i>ANEXO B2. Cuestionario Profesorado</i> .....	219
<b>ANEXO C-Estudio III</b> .....	223
<i>ANEXO C1-Artículo III</i> .....	223
ANEXO C1.1-Categorías de análisis .....	223
C1.1.1. Matriz General de Análisis .....	223
C1.1.2. Uso de las TIC .....	224
C1.1.3. Demanda del alumno .....	225
C1.1.4. Ayudas pedagógicas del docente .....	226
C1.1.5. Exigencia cognitiva .....	227
C1.1.5. Estructura de participación .....	227
C1.1.6. Participantes y nivel de participación .....	227
C1.1.7. Grado de apertura de la interacción (Inicial-Final) .....	228
ANEXO C1.2. distribución cronológica de los ciclos comunicativos .....	229
<i>ANEXO C2. Artículo IV</i> .....	231
Anexo C2.1. Acuerdo Cesión Derechos .....	231
<b>ANEXO D-Estudio IV</b> .....	233
<i>ANEXO D1.Cuestionario Usos de las TIC para los alumnos</i> .....	233
<i>ANEXO D.2.Prueba de evaluación del conocimiento de los alumnos sobre el movimiento de objetos</i> .....	239

## Lista de Tablas<sup>1</sup>

<b>Tabla i:</b> <i>Resumen de los Estudios realizados en la Tesis Doctoral</i> .....	xiii
<b>Table ii.</b> <i>Summary of Doctoral Dissertation Studies</i> .....	xix
<b>Tabla iii.</b> <i>Resumen los capítulos que componen la SECCIÓN I-ANTECEDENTES TEÓRICOS</i> .....	3
<b>Tabla iv.</b> <i>Resumen de los Objetivos de la Tesis Doctoral</i> .....	55
<b>Table v.</b> <i>Summary of the Doctoral Dissertation's aims</i> .....	61
<b>Tabla vi.</b> <i>Resumen de los Resultados obtenidos en la Tesis Doctoral</i> .....	187
<b>Tabla vii.</b> <i>Limitaciones y Líneas Futuras de Investigación</i> .....	194
<b>Table viii.</b> <i>Summary of the Results obtained in the Doctoral Dissertation</i> .....	201
<b>Table ix.</b> <i>Limitations and Future Research Lines</i> .....	207

### Tablas Sección Antecedentes Teóricos

<b>Tabla 2.1.</b> <i>Relación entre las demandas de la Sociedad del Conocimiento, las habilidades y competencias requeridas y las estrategias de aprendizaje</i> .....	17
<b>Tabla 2.2.</b> <i>Entorno virtual y competencias básicas</i> .....	18
<b>Tabla 2.3.</b> <i>Características de las TIC</i> .....	19
<b>Tabla 3.1.</b> <i>Teorías implícitas sobre el aprendizaje</i> .....	29

### Tablas Sección Estudios Empíricos

<b>Table 6.1.1.</b> <i>Summary of teacher Epistemic Beliefs</i> .....	72
<b>Table 6.1.2.</b> <i>Summary of Pedagogical Beliefs About ICT</i> .....	73
<b>Table 6.1.3.</b> <i>Summary of Pedagogical Practices with ICT</i> .....	75
<b>Table 6.1.4.</b> <i>Summary of Levels of Learning with Technologies</i> .....	76
<b>Table 6.1.5.</b> <i>Classification Framework for Technology- Enabled Practice (FrameTEP)</i> .....	77
<b>Table 6.1.6.</b> <i>Classification Framework of Lucy's Use of Reading Quest</i> .....	78
<b>Table 6.1.7.</b> <i>Classification Framework of Judy's Use of Ratchet and Clank</i> .....	79
<b>Table 6.1.8.</b> <i>Classification Framework of Janet's Use of Kinectimals Xbox Kinect</i> .....	79
<b>Table 6.1.9.</b> <i>Classification Framework for Technology- Enabled Practice (FrameTEP)</i> .....	81
<b>Table 6.2.1.</b> <i>Learning Outcomes</i> .....	97
<b>Table 6.2.2.</b> <i>Information Processing</i> .....	98

---

<sup>1</sup> Tablas x,y: x = nº capítulo; y = nº de tabla.

Tablas x,y,z: x= nº de capítulo; y= manuscrito, z= nº de tabla.

<b>Table 6.2.3.</b> <i>Psychological Processes</i> .....	98
<b>Table 6.2.4.</b> <i>Learning Conditions</i> .....	99
<b>Table 6.2.5.</b> <i>Teachers' educational beliefs according to subjects taught</i> .....	103
<b>Table 6.2.6.</b> <i>Teachers' uses of ICT according to subjects taught</i> .....	104
<b>Table 6.2.7.</b> <i>Teachers' beliefs according to educational stage</i> .....	105
<b>Table 6.2.8.</b> <i>Teachers' uses of ITC according to educational stage</i> .....	106
<b>Table 6.2.9.</b> <i>Summary of results</i> .....	108
<b>Table 7.1.1.</b> <i>Adapted from Bloom's Revised Taxonomy (Krathwohl, 2002)</i> .....	121
<b>Table 7.1.2.</b> <i>Information Processing. Adapted from Pozo and Postigo (2000).</i> .....	122
<b>Table 7.1.3.</b> <i>Examples of activities in DLE</i> .....	125
<b>Table 7.1.4.</b> <i>Description of categories of analysis</i> .....	127
<b>Table 7.1.5.</b> <i>Example of analysis of a Communication Cycle</i> .....	128
<b>Table 7.1.6.</b> <i>Summary of findings</i> .....	138
<b>Table 7.2.1.</b> <i>Definition of categories, code rules and examples</i> .....	154
<b>Table 7.3.1.</b> <i>Sample characteristics</i> .....	166
<b>Table 7.3.2.</b> <i>Levels of complexity in explanations</i> .....	170
<b>Table 7.3.3.</b> <i>Summary of answer to the questionnaire</i> .....	170
<b>Table 7.3.4.</b> <i>Distribution of groups according to Pre- and Post-test explanations</i> .....	172
<b>Table 7.3.5.</b> <i>Perception of the effect of angle on launching.</i> .....	172
<b>Table 7.3.6.</b> <i>Distribution of groups according to perception of angle in pre- and post-tests.</i> ..	173

## Lista de Figuras

<i>Fig.5.1. Ciclo de aprendizaje experiencial (adaptado de Kolb, 1984).....</i>	<i>46</i>
<i>Fig.6.2.1. Profile of teachers' educational beliefs about ICT. ....</i>	<i>102</i>
<i>Fig.6.2.2. Profile of ICT use by teachers .....</i>	<i>102</i>
<i>Fig.7.1.1. Relationship among the parts of the interactive triangle according to educational culture. ....</i>	<i>120</i>
<i>Fig.7.1.2. Structure of activity in classroom .....</i>	<i>126</i>
<i>Fig.7.1.3. Activities chosen by students.....</i>	<i>129</i>
<i>Fig 7.1.4. ICT Uses required by Activities according to Information Management.....</i>	<i>130</i>
<i>Fig.7.1.5. ICT Uses required by the Activities according to Materials Production.....</i>	<i>130</i>
<i>Fig. 7.1.6. Distribution of Student Demand.....</i>	<i>131</i>
<i>Fig 7.1.7. Student demand according to Activity chosen .....</i>	<i>132</i>
<i>Fig.7.1.8. Cognitive Demand of Student Request according to Activities Chosen.....</i>	<i>132</i>
<i>Fig 7.1.9. Distribution of Teacher's Pedagogical Assistance .....</i>	<i>133</i>
<i>Fig.7.1.10. Distribution of Teacher's Pedagogical Assistance according to .....</i>	<i>134</i>
<i>Activities chosen by Students .....</i>	<i>134</i>
<i>Fig.7.1.11. Cognitive Demand of Teacher's Pedagogical Assistance according to Activities chosen by Students.....</i>	<i>135</i>
<i>Fig.7.1.12. Student Participation Level (Planning / Supervision) according to Activities chosen .....</i>	<i>136</i>
<i>Fig. 7.1.13. Distribution of Cycle Aperture (Initial-Final).....</i>	<i>137</i>
<i>Fig. 7.1.14. Cycle Aperture according to Activities chosen by Students .....</i>	<i>138</i>
<i>Fig. 7.2.1: Procedure of analysis in content analysis.....</i>	<i>149</i>
<i>Fig. 7.2.2.Types of Relationship among the parts of the interactive triangle .....</i>	<i>150</i>
<i>Fig.7.2.3. Structure of session according to Cycles of Communication .....</i>	<i>151</i>
<i>Fig.7.2.4. Classroom Activity Structure and dimensions of analysis .....</i>	<i>151</i>
<i>Fig.7.2.5. General structure of content analysis process .....</i>	<i>155</i>
<i>Fig.7.3.1. Angry Birds screenshot .....</i>	<i>164</i>
<i>Fig.7.3.2. Example of two identical objects with uniform rectilinear motion and different velocity. ....</i>	<i>167</i>
<i>Fig.7.3.3. Example of two objects with different mass, uniform rectilinear movement and the same velocity.....</i>	<i>167</i>
<i>Fig.7.3.4. Example of two identical objects with parabolic motion and different velocity. ....</i>	<i>167</i>
<i>Fig.7.3.5. Example of two objects with different mass, parabolic motion and the same velocity. ....</i>	<i>167</i>

<i>Fig.7.3.6. Angry Birds screen where students were required to work.....</i>	<i>168</i>
<i>Fig.7.3.7. Example of “speed-mass belief”. The heavier object falls sooner than the lighter object even though they both have the same initial speed.....</i>	<i>169</i>
<i>Fig.7.3.8. Example of correct answer for the effect of velocity on object motion.....</i>	<i>169</i>
<i>Fig.7.3.9. Example of correct description of the trajectory of object motion.....</i>	<i>169</i>
<i>Fig.7.3.10. Proportion of total correct answers per group.....</i>	<i>171</i>

# **SECCIÓN I**

# **ANTECEDENTES TEÓRICOS**

---



**Tabla iii. Resumen de los capítulos que componen la SECCIÓN I-ANTECEDENTES TEÓRICOS:**

CAPÍTULOS	RESUMEN	FUNCIÓN
<b>Capítulo 1.</b> TIC, Cultura, Sociedad y Desarrollo Cognitivo: una mirada evolutiva	Descripción de la relación y construcción conjunta mente y cultura	Marco General
<b>Capítulo 2.</b> TIC, Educación y Aprendizaje en el s. XXI	Descripción de los nuevos retos educativos en el s. XXI	
<b>Capítulo 3.</b> Concepciones y teorías implícitas: allanando el terreno para una integración de las TIC en el aula	Formulación sobre concepciones y teorías implícitas como factor fundamental en la integración educativa de las TIC en el aula	Justificación Estudios I y II (Artículos I y II)
<b>Capítulo 4.</b> Las TIC en la práctica: hacia una mediación entre los elementos del triángulo interactivo	Identificación de las nuevas funciones y finalidades de los diferentes elementos educativos cuando su acción es mediada por las TIC	Justificación Estudio III (Artículos III y IV)
<b>Capítulo 5.</b> Videojuegos y <i>serious games</i> como ejemplo de integración educativa de las TIC	Análisis de los videojuegos y <i>serious games</i> como instrumentos de aprendizaje	Justificación Estudio IV (Artículo V)

## CAPÍTULO 1. TIC, CULTURA, SOCIEDAD y DESARROLLO COGNITIVO: UNA MIRADA EVOLUTIVA

### Resumen

El capítulo que se presenta a continuación describe fundamentalmente la relación histórica y evolutiva entre el desarrollo tecnológico y cognitivo del ser humano, a partir del cual se han conformado diferentes formas de expresión cultural y organización económica y social. La introducción y generalización del uso de las TIC vertebró una sociedad que demanda nuevas formas de ser y estar en el mundo.

*"I've seen things you people wouldn't believe".* Así de contundente se mostraba el replicante Roy Batty (Rutger Hauer) en la escena final de la brillante *Blade Runner* (Ridley Scott, 1982), obra maestra del cine de ciencia ficción. Como si nos encontrásemos interpretando el mismo papel, esa es la sensación que nos recorre cuando echamos la mirada atrás. Nadie podía atisbar hace apenas unas décadas lo que para nosotros hoy es cotidiano: comunicarnos en tiempo real con aquellos que se encuentran a miles de kilómetros de distancia, tener acceso casi ilimitado en cualquier momento y lugar a información de todo tipo, realizar toda suerte de transacciones sin tener la necesidad de salir de tu casa, participar de realidades virtuales donde poder desarrollar actividades muy diversas e incluso una nueva identidad, etc.

Como acertadamente señalan Coll y Monereo: *"estamos asistiendo desde hace algunas décadas a la aparición de una nueva forma de organización económica, social, política y cultural, identificada como Sociedad de la Información (SI), que comporta nuevas maneras de trabajar, de comunicarnos, de relacionarnos, de aprender, de pensar y, en suma, de vivir"* (2008, p.19). Igbaria, Shayo y Olfman (1999) hablan de una "sociedad virtual" caracterizada por una serie de elementos, entre los que se encuentran la economía y política global, la comunicación entre iguales que trasciende el espacio y el tiempo, y las Tecnologías de la Información y Comunicación (de ahora en adelante TIC), por citar sólo unos pocos. Como señala Castells (2001), nos encontramos frente a un nuevo "paradigma tecnológico", causa, y a la vez consecuencia, de la actual forma de ser y estar en el mundo.

### 1.1. Tecnología, cultura y desarrollo cognitivo: un breve recorrido por la historia

La forma en la que la cognición humana ha evolucionado corre pareja con el desarrollo de la cultura en la que emerge (Donald, 1993a). Así, las características de nuestro sistema cognitivo, con sus propiedades y constricciones, delimita en cierto sentido tanto la naturaleza de las interacciones sociales como los productos culturales elaborados. Estos productos, ya sean materiales (como las herramientas para cazar) o sobre todo simbólicos (como el sistema numérico), repercuten a su vez en la estructura y funciones de la mente, convirtiéndose en verdaderos instrumentos vertebradores del pensamiento (Clark y Chalmer, 1998; Pérez-Echeverría, Martí y Pozo, 2010; Shaffer y Clinton, 2006). El ejemplo más paradigmático es el lenguaje, producto cultural y a la vez herramienta esencial para el desarrollo de la mente (Clark, 1996; Nelson, 1998; Vygotski, 1986)

En este sentido, la historia de la evolución del ser humano puede ser descrita en gran parte atendiendo al desarrollo de su tecnología. Desde la modificación intencional de la

primera piedra hace aproximadamente 2.5 millones de años, el proceso de elaboración de instrumentos más sofisticados se ha prolongado hasta nuestros días (Ambrose, 2001; Semaw et al., 1997; Stout y Chamiande, 2007, 2009, 2012). Foley y Lahr (2003) describen la relación existente entre los cambios producidos en la tecnología (lítica) desarrollada por los diferentes homínidos y sus implicaciones culturales. Así, mientras los más remotos *homo ergaster* y *homo erectus* apenas eran capaces de hacer pequeñas modificaciones en piedra, los más recientes *homo sapiens* elaboraban herramientas más sofisticadas y funcionales. Esta mayor precisión en la producción y manipulación de estos materiales dio lugar a una evolución que culminaría con la aparición de las primeras marcas y registros gráficos, lo que a la postre se convertiría en los primeros signos materiales de un desarrollo cultural.

Según Tomasello (2000), ese desarrollo cultural ha evolucionado de forma cualitativamente distinta en el ser humano con respecto al resto de especies que también han elaborado algunos mecanismos de transmisión cultural (por ejemplo, el caso de los chimpancés), transmisión definida de forma muy amplia como transferencia de información no codificada genéticamente. Este proceso es consecuencia, afirma el autor, de un sistema cognitivo adaptado biológicamente a la cultura de forma particular en cada una de ellas. Las diferencias se perciben claramente cuando comparamos sus capacidades para el aprendizaje social. Los chimpancés, por ejemplo, son capaces de aprender cosas observando el comportamiento de los otros cuando utilizan herramientas, pero eso no significa que puedan imitar o copiar el comportamiento estratégico de otros individuos. Por ejemplo, a través de la observación pueden aprender que una nuez puede ser partida y que en su interior almacena alimento, o que golpeando una fruta que se encuentra localizada en una altura elevada, ésta caerá al suelo. Según Boesch y Tomasello (1998), lo que aprende el chimpancé en esta situación son ciertas “affordances” del contexto, difícilmente accesibles si no es a través de esta observación, que permite al individuo desarrollar sus propias estrategias de comportamiento. Este proceso es llamado “emulation learning” (Tomasello, 1996, 1999).

El ser humano, sin embargo, es capaz de reproducir estratégicamente las acciones de otros individuos en la medida que reconoce al otro como un agente intencional, es decir, como un sujeto cuyo comportamiento responde a un objetivo o meta determinada. Tomasello (1996, 1999, 2000) denomina este proceso “aprendizaje imitativo”. Esta diferencia en la forma de aprender supone el origen de las enormes diferencias en relación con la evolución cultural de las especies. Comprender las intenciones del otro y ponerlas en relación con las de uno mismo, afirma el autor, permite al individuo acceder a todos los artefactos, materiales y simbólicos, desarrollados a lo largo del tiempo.

Basado en estas evidencias, Donald (1993) describe el desarrollo cognitivo humano como un proceso evolutivo que atraviesa diferentes etapas o estadios, en cada una de las cuales se desarrolla sus propias formas de pensamiento y conocimiento. Según Kaput y Shaffer (2002), en la actualidad estaríamos asistiendo a la transición hacia un nuevo estadio, promovido por la introducción y expansión de las TIC. A continuación profundizo en cada una de esas etapas.

## 1.2. De la cultura episódica a la cultura virtual

En su libro *Los Orígenes de la Mente Moderna* (Donald, 1991) el evolucionista Merlin Donald, apoyándose en evidencias procedentes de la Arqueología, Lingüística o la Psicología, entre otras disciplinas, desarrolla la idea de que la cultura humana ha sufrido una serie de transiciones como consecuencia de cambios específicos en nuestro sistema cognitivo. Estos cambios a su vez produjeron modificaciones en nuestro desarrollo cerebral, así como nuevas formas de comunicación e interacción social (Kaput y Shaffer, 2002).

La *primera etapa*, cuyo origen se remonta hace más de tres millones de años a los primates más remotos, describe básicamente la cognición de nuestros ancestros y la de nuestros parientes más cercanos en la escala evolutiva. Según Donald, su sistema cognitivo se caracterizaría por un pensamiento “episódico” basado en una recuperación literal de las experiencias vividas. Es decir, los primates podrían recordar acontecimientos (como por ejemplo, quién es el macho dominante de la manada), pero no serían capaces de representar o generalizar la información más allá de un proceso puramente asociativo (como por ejemplo, la relación que algunos primates establecen entre sonidos y tipos de amenaza). En este sentido, se encontrarían profundamente anclados a la realidad de la cuál difícilmente podrían despegarse.

Esta cognición episódica fue la base para una interacción social rudimentaria, cuyo desarrollo permitió a los primeros homínidos, hace aproximadamente un millón y medio de años, utilizar el cuerpo y los objetos próximos a él como instrumentos de representación. Donald denomina a esta *segunda fase mimesis*. Este etapa supuso un periodo crítico para el desarrollo cognitivo del ser humano pues en él se encuentra el origen de nuestra capacidad referencial y simbólica (Kaput y Shaffer, 2002). De forma coherente con los argumentos esgrimidos por Tomasello (1996, 1999), esa capacidad revelaba el nacimiento de una conciencia primigenia que separaba el “yo” del resto del mundo y la base de una intencionalidad, voluntaria y controlable. Estas nuevas formas de comunicación explican en parte los cambios sociales importantes que se dieron entonces, como fue la elaboración de herramientas cada vez más sofisticadas o la aparición de campamentos estacionales, todo ello antes de que el lenguaje fuera fisiológicamente posible (Kaput y Shaffer, 2002).

Fue precisamente el desarrollo del lenguaje hace aproximadamente 300.000 años lo que dio paso a una *tercera etapa* basada en la transmisión narrativa de conocimientos culturales, denominada por Donald *cultura mítica*. La materialización de un lenguaje articulado dotó al individuo de una herramienta integradora del pensamiento. Lo que antes eran datos y hechos desconectados, ahora era información relacionada. Con el nacimiento de la oralidad, emergieron nuevas formas de creación y organización de la experiencia humana que desembocaron en transformaciones culturales, sociales y anatómicas de enorme relevancia. La propia estructura del lenguaje supuso una nueva forma de representarse el mundo, basada en una construcción narrativa de la realidad. Como afirma Martí (2003), “*el lenguaje afianzó el carácter representativo de la acción y permitió afinar los modelos de la realidad a través de la creación de los mitos, construcciones importantes que han contribuido a cohesionar cualquier sociedad oral en torno a determinadas formas culturalmente relevantes*” (p. 32)

Poco después desde el punto de vista evolutivo, hace aproximadamente unos 40.000 años, se produce con la llegada de los primeros registros gráficos la transición hacia una *cuarta etapa*. Donald la identifica como el nacimiento de una *cultura teórica*, fruto de la externalización de la memoria. En un primer momento esos registros eran coherentes con una cultura mítica: se encontraban en el centro de actos ceremoniales basados en temas narrativos, como la fertilidad o la caza (Donald, 1993b; Martí, 2003). Poco a poco, y como consecuencia del desarrollo de nuevas formas de organización e interacción social (como por ejemplo, el aumento de formas rudimentarias de transacción económica para regular fundamentalmente el intercambio de alimentos), esas representaciones se fueron haciendo cada vez más sofisticadas y sistemáticas. Ya no sólo era necesario diferenciar cualitativamente aquello que se quería representar (ganado, trigo, frutos, etc.), sino que también era necesario cuantificarlo. Estas presiones medioambientales fueron el origen del desarrollo de sistemas externos de representación, como la escritura o la notación numérica (Andersen, Scheuer, Pérez Echeverría y Teubal, 2009; Donald, 1991; Martí, 2003).

La aparición de estos sistemas externos de representación modificó la arquitectura funcional de la mente humana en su capacidad para almacenar y recuperar la información (Martí, 2003). La posibilidad de registrarla de forma permanente a través de estas representaciones externas, además de reproducirla y objetivarla, permitió superar las limitaciones impuestas por nuestra memoria biológica. Este cambio cualitativo, señalan algunos autores, sería el origen de la actual ciencia moderna (Martí, 2003; Olson, 1994; Olson y Marshall, 1994).

A pesar de su potencialidad como herramientas de mediación del pensamiento, estos sistemas representacionales son, como afirman Shaffer y Clinton (2006), sistemas estáticos. Cualquier inscripción que se realice sobre un papel permanece inalterable hasta que el mismo u otro individuo no la modifiquen. Es decir, necesitan de la acción del ser humano para transmitir nuevos significados. Esta realidad, desde la introducción hace ya algunas décadas de los medios computacionales, está cambiando. Cuando introducimos en nuestra base de datos la información recogida previamente a través de unos cuestionarios, es el propio programa informático el que transforma los datos en una preciosa gráfica. Lo mismo ocurre cuando queremos buscar por internet la localización de ese restaurante nuevo que acaban de abrir. En ambos casos, la información original es modificada por el propio sistema sin mediación del individuo. Pocos saben (ni quieren saber) qué ocurre en el interior del ordenador para que yo pueda seguir redactando este documento. Esta naturaleza dinámica de las representaciones elaboradas por los dispositivos digitales que nos rodean es la razón por la que, según Kaput y Shaffer (2002), nos encontramos en plena transición hacia una *quinta etapa* identificada como el nacimiento de una *cultura virtual*.

Pero más allá de la naturaleza de estas representaciones, que hacen referencia más bien a una nueva forma de actividad cognitiva, esta nueva *cultura virtual* supone la materialización de una serie de cambios radicales, producidos en nuestra sociedad como consecuencia de la introducción y expansión de las TIC en nuestro día a día, conformando lo que hoy se conoce como *Sociedad de la Información* (SI). Coll y Monereo (2008) identifican algunas de las características que mejor definen, a su juicio, esta nueva realidad:

- El contexto de las actividades humanas ya no se limita al espacio físico en el que surgen. En la SI el horizonte se extiende indefinidamente, creando un vasto escenario de múltiples interrelaciones. Esta es la razón por la que algunos autores han acuñado también el término de “Sociedad Red” para referirse a este nuevo contexto (Castells, 2001; van Dijk, 2012).
- La percepción del tiempo en relación con la adquisición de información y conocimiento se ha visto modificada. Lo que antes nos podía llevar semanas en encontrar (por ejemplo, una revisión bibliográfica), ahora accedemos a ello en apenas unos minutos. Los procesos de manipulación de información (consumo, gestión, producción, etc), y sus consecuencias, han aumentado su velocidad vertiginosamente. Esto desemboca en cambios y transformaciones culturales continuas (modas, valores éticos y estéticos, etc) que en muchos casos son imprevisibles. Zygmunt Bauman (2000) empleó el término de “Sociedad Líquida” para referirse a esa noción de inestabilidad.
- El aumento desmesurado en la producción de información, así como el acceso a la misma de cada vez más sectores de la población, tiene en muchos casos como consecuencia la sobreabundancia y el ruido informativo. Como algunos autores apuntan (Coll y Monereo, 2008; Miralles y Sancho, 2004), “el bombardeo continuo” al que nos vemos sometidos diariamente, no sólo no nos hace estar más y mejor informados (pues en muchos casos se desconocen los criterios para seleccionar la información fiable de la que no lo es), sino que a menudo se convierte en auténtica “infoxicación”, fruto de una verdadera “ecología de la dispersión”.
- La posibilidad de transmitir y acceder a un volumen de información tan elevado en cualquier lugar y de forma casi instantánea globaliza las prácticas culturales. Ciertos valores y normas sociales (como el consumo, el culto al cuerpo, la búsqueda de la felicidad, etc) se comparten con mayor facilidad.
- Es tal la velocidad a la que se suceden los cambios, que apenas existen espacios y tiempos para la abstracción y la reflexión. La SI propone un modelo de pensamiento que sobrepone la rapidez y superficialidad frente a la reflexión reposada y profunda. Como señala Nicholas Carr: “*la lectura profunda que solía venir naturalmente se ha convertido en un esfuerzo*” (2011, p.17 de la versión en castellano).
- A pesar de que cada vez son más las personas que tiene acceso a las TIC, no se da por igual en todas las partes del mundo. Una de las consecuencias de este fenómeno es la aparición de nuevas clases sociales, los info-ricos y los info-pobres, que están afectando las formas de distribución de la riqueza y el poder.
- Por último, los autores señalan la preeminencia de la cultura de la imagen y del espectáculo. Según ellos, las TIC favorecen unas formas de expresión que modifican nuestra manera de hacer y estar en el mundo.

### 1.3. De la Sociedad de la Información a la Sociedad del Conocimiento

La metáfora de la “Sociedad de la Información” (SI) fue utilizada por primera vez por Kohyama (1968) para referirse al marco sobre el que desarrollar las políticas nacionales en Japón (Masuda, 1981). No fue sin embargo hasta finales de los años 80 cuando el término se hizo muy popular a raíz de la introducción y expansión progresiva de las TIC en la realidad social (Anderson, 2008). Como señala Bell (1979), el éxito de este concepto se debió a su

capacidad para reflejar con precisión un sistema económico globalizado basado fundamentalmente en la producción de información.

Sin embargo, a comienzos de los años 90 una nueva metáfora para referirse a esta realidad social se abrió camino: era la *Sociedad del Conocimiento* (SC). Mientras que la SI centraba su atención en “la explosión de información” como consecuencia del uso masivo de las TIC, la SC se centraba en la gestión y el tratamiento de esa información. Ya no se trataba únicamente de su producción casi ilimitada y descontrolada, sino que ahora lo relevante era ser capaz de ordenar y organizar ese caos informativo, dotarlo de significado con el objetivo de controlar y predecir el mundo que nos rodea (Pozo, 2008).

Transitar de una sociedad a otra suponía, y supone, ir más allá de los propios datos y hechos a los que constantemente, queramos o no, estamos expuestos. En términos de Kirsh y Maglio (1994), en la SI bastaba con guiarse por *metas pragmáticas*, es decir, con metas dirigidas al éxito o adquisición de un *objeto* concreto de aprendizaje (Pozo, 2008). Así, cuando se trata el tema del cambio climático guiado por metas pragmáticas basta con acumular información y datos relativos al fenómeno. Por ejemplo, identificar y enumerar las causas del cambio, conocer el porcentaje de emisiones contaminantes de cada uno de los países, reconocer alguno de los efectos, etc.

Sin embargo, en la SC no vale solamente con apropiarse del *objeto* de aprendizaje. Lo que ahora se demanda es tomar conciencia, explicitar nuestra posición y actitud con respecto a ese objeto. Supone dar sentido y significado al fenómeno en cuestión, tratando de comprender la complejidad que tras de sí encierra. En este sentido, y continuando con la terminología de Kirsh y Maglio (1994), cuando nos guiamos por *metas epistémicas* son muchas más las preguntas formuladas que las respuestas contestadas, de forma que lo que se busca no es tanto reducir la incertidumbre sino saber gestionarla adecuadamente. Así, tratar la cuestión del cambio climático guiado por metas epistémicas exige reflexionar acerca de los múltiples niveles que lo atraviesa: ¿de qué manera repercute mi acción sobre el cambio climático?, ¿qué puedo hacer para reducir las consecuencias?, ¿por qué resulta tan complicado revertir el efecto?, etc.

Como señalan Voogt y Roblin (2012), este aumento vertiginoso en la complejidad de una sociedad que pretende avanzar de la información al conocimiento demanda la identificación y adquisición de competencias que deben ser adquiridas para poder desenvolvernó en ella de forma efectiva. Las llamadas competencias del s. XXI se caracterizan de forma genérica por ser a) transversales, es decir, necesarias para diferentes campos y dominios. Por ejemplo, la competencia cívica o ciudadana no sólo se limita a un espacio concreto como el trabajo o la escuela, sino que debe vertebrar cada uno de los contextos socialmente relevantes en los que nos desenvolvemos; b) multidimensionales, es decir, se componen de entidades de naturaleza diversa, como es el conocimiento declarativo, procedimental y actitudinal; y c) están asociadas con comportamientos y procesos psicológicos superiores, necesarios para resolver problemas complejos y situaciones impredecibles (Gordon et al., 2009; OCDE, 2005; Westera, 2001).

En este sentido, en relación con la competencia digital, los ciudadanos de esta nueva sociedad del conocimiento deben alfabetizarse no sólo *tecnológicamente* sino también

*informacionalmente* (Horton, 1983; Leu et al., 2007). Es decir, ya no basta únicamente con tener los recursos técnicos para acceder a la información, ahora es necesario ser capaz de identificarla, seleccionarla, organizarla y valorarla críticamente, con el objetivo de elaborar una opinión propia argumentada y justificada.

En una sociedad donde en muchos casos los individuos más jóvenes, denominados por Marc Prensky (2001) *nativos digitales*, están tecnológicamente mejor alfabetizadas que aquellas con más experiencia, a los que se refiere como *inmigrantes digitales*, no ocurre lo mismo sin embargo en la dimensión informacional. Este sin duda es uno de los retos a los que se deben enfrentar nuestros sistemas educativos, presionados por unas transformaciones sociales que demandan cambios para dar respuesta a esas exigencias. En el Capítulo 2 reflexionamos acerca de los nuevos retos y desafíos educativos, así como la forma de enfrentarse a ellos, donde las TIC, indiscutiblemente, juegan un papel fundamental.

## Referencias

- Ambrose, S. H. (2001). Paleolithic technology and human evolution. *Science*, 291 (5509), 1748-1753.
- Andersen, C., Scheuer, N., Echeverría, M. D. P. P., y Teubal, E. (2009). *Representational systems and practices as learning tools*. Rotterdam: Sense Publishers.
- Anderson, R. E. (2008). Implications of the information and knowledge society for education. En J. Voogt y G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 5-22). Springer US.
- Bauman, Z. (2000). *Liquid modernity*. Cambridge, UK: Polity Press.
- Bell, D. (1979). The social framework of the information society. In M. L. Dertouzos, y J. Moses (Eds.), *The computer age: A twenty-year view* (pp. 163-211). Cambridge, MA: MIT.
- Boesch, C., y Tomasello, M. (1998). Chimpanzee and human cultures. *Current anthropology*, 39(5), 591-614.
- Carr, N. (2011). *Superficiales. ¿Qué está haciendo Internet con nuestras mentes?* Madrid: Taurus.
- Castells, M. (2001). Internet y la sociedad red. *La factoría*, 14, 15.
- Clark, A., y Chalmers, D. (1998). The extended mind. *Analysis*, 58(1), 7-19.
- Clark, H. H. (1996): *Using Language*. Cambridge: Cambridge University Press.
- Coll, C., y Monereo, C. (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Crawford, S. (1983). The origin and development of a concept: the information society. *Bulletin of the Medical Library Association*, 71(4), 380.
- Donald, M. (1991). *Origins of the modern mind: Three stages in the evolution of culture and cognition*. Harvard University Press.
- Donald, M. (1993a). Human cognitive evolution: What we were, what we are becoming. *Social Research*, 143-170.
- Donald, M. (1993b). Precis of Origins of the modern mind: Three stages in the evolution of culture and cognition. *Behavioral and brain sciences*, 16(04), 737-748.
- Foley, R., y Lahr, M. M. (2003). On stony ground: lithic technology, human evolution, and the emergence of culture. *Evolutionary Anthropology: Issues, News, and Reviews*, 12(3), 109-122.



- Gordon, J., Halsz, G., Krawczyk, M., Leney, T., Michel, A., Pepper, D., Putkiewicz, E., y Wisniewski, W. (2009) *Key competences in Europe. Opening doors for lifelong learners across the school curriculum and teacher education* (Warsaw, Center for Social and Economic Research on behalf of CASE Network).
- Horton Jr, F. W. (1983). Information Literacy vs. Computer Literacy. *Bulletin of the American Society for Information Science*, 9(4), 14-16.
- Igbaria, M., Shayo, C., y Olfman, L. (1999, April). On becoming virtual: The driving forces and arrangements. In *Proceedings of the 1999 ACM SIGCPR conference on Computer personnel research* (pp. 27-41). ACM.
- Kaput, J. J., y Shaffer, D. W. (2002). On the development of human representational competence from an evolutionary point of view. In *Symbolizing, modeling and tool use in mathematics education* (pp. 277-293). Springer Netherlands
- Kirsh, D., y Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive science*, 18(4), 513-549.
- Kohyama, K. (1968). *Introduction to information society theory*. Tokyo, Japan: Chuo Koron.
- Leu, D. J., Zawilinski, L., Castek, J., Bannerjee, M., Housand, B., Liu, Y., y O'Neil, M. (2007). What is new about the new literacies of online reading comprehension? En A.Berger, L.Rush, y J. Eakle (Eds.) *Secondary school reading and writing: What research reveals for classroom practices*. Chicago, IL: NCTE/NCRL.
- Martí, E. (2003). *Representar el mundo externamente. La construcción infantil de los sistemas externos de representación*. Madrid: Machado Libros
- Masuda, Y. (1981). *The information society as post-industrial society*. Bethesda, MD: World Future Society.
- Miralles i Puig, L., y Sancho Vinuesa, T. (2004). *Internet y la red de universidades catalanas*. Informe de investigación (documento de síntesis).
- Nelson, K. (1998). *Language in cognitive development: The emergence of the mediated mind*. Cambridge University Press.
- Organisation for Economic Co-Operation and Development [OECD] (2005). *The definition and selection of key competencies* [Executive Summary]. Disponible en: <http://www.oecd.org/dataoecd/47/61/35070367.pdf>, consultado el 10 de Febrero de 2016
- Olson, D. R. (1994). *The world on paper: The conceptual and cognitive implications of writing and reading*. Cambridge University Press.
- Olson, D. R., y Marshall, J. C. (1994). The world on paper. *Nature*, 371(6499), 665-665.
- Pérez-Echeverría, M. P., Martí, E., y Pozo, J. I. (2010). Los sistemas externos de representación como herramientas de la mente. *Cultura y Educación*, 22(2), 133-147.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon*, 9(5), 1-6.
- Scott, R. (1982). *Blade Runner* [cinta cinematográfica]. U.S: Warner Bros
- Shaffer, D. W., y Clinton, K. A. (2006). Toolforthoughts: Reexamining thinking in the digital age. *Mind, Culture, and Activity*, 13(4), 283-300.
- Semaw, S., Renne, P., Harris, J. W. K., Feibel, C. S., Bernor, R. L., Fesseha, N., et al. (1997). 2.5-Million-year-old stone tools from Gona, Ethiopia. *Nature*, 385, 333-336. January 23 1997.

- Stout, D., y Chaminade, T. (2007). The evolutionary neuroscience of tool making. *Neuropsychologia*, 45(5), 1091-1100.
- Stout, D., y Chaminade, T. (2009). Making tools and making sense: complex, intentional behaviour in human evolution. *Cambridge Archaeological Journal*, 19(01), 85-96.
- Stout, D., y Chaminade, T. (2012). Stone tools, language and the brain in human evolution. *Philosophical Transactions of the Royal Society B*, 367(1585), 75-87.
- Tomasello, M. (1996). Do apes ape? In J. Galef & C. Heyes (Eds.), *Social learning in animals: The roots of culture* (pp. 319–346). New York: Academic Press.
- Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.
- Tomasello, M. (2000). Culture and cognitive development. *Current Directions in Psychological Science*, 9(2), 37-40.
- Van Dijk, J. (2012). *The network society*. UK: Sage Publications.
- Voogt, J., y Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies*, 44(3), 299-321.
- Vygotsky, L. S. (1986). *Thought and Language*. Cambridge MA: MIT Press.
- Westera, W. (2001). Competences in education. A confusion of tongues. *Journal of Curriculum Studies*, 33(1), 75–88.
- Zygmunt, B. (2000). *Liquid modernity*. Polity, Cambridge.

## CAPÍTULO 2. TIC, EDUCACIÓN Y APRENDIZAJE EN EL s. XXI<sup>1</sup>

---

### Resumen

El presente capítulo describe fundamentalmente como la Sociedad del Conocimiento demanda nuevas finalidades educativas para formar plenamente a los futuros ciudadanos. En ese escenario, reflexionamos sobre las diferentes posiciones que existen en relación con el papel que deben jugar las TIC, desde aquellos más optimistas que opinan que pueden ser herramientas de mejora y crecimiento personal y social, hasta los más pesimistas que consideran que su utilización empobrece las formas de pensar y comunicarse.

Aprender hoy en día es una actividad compleja y paradójica (Pozo, 2016). Cada vez es mayor el tiempo y más numerosos los espacios donde desarrollamos actividades cuyo objetivo es el aprendizaje de algún tipo de conocimiento o comportamiento, y cada vez es mayor la frustración y la sensación de desánimo por no alcanzar los objetivos propuestos. Desde los primeros meses de vida, donde los procesos y mecanismos de aprendizaje implicados son más de carácter asociativo (p.ej. reconocer el rostro o la voz de los progenitores), hasta nuestra edad adulta, caracterizada por contextos más complejos (recuerde si no el tiempo y el esfuerzo que le costó aprender a conducir, a cocinar o a dominar con soltura el SPSS), la mayoría de los escenarios en los que nos desenvolvemos exigen nuevos aprendizajes. El término anglosajón “lifelong learning” fue acuñado para referirse a esta idea de aprendizaje perpetuo a lo largo de nuestra vida (Coolahan, 2002).

Sin embargo, y a pesar de dedicar tanto esfuerzo y recursos a la ardua tarea de aprender, la sensación de malestar es notable en muchos de los que participan en los diversos contextos educativos. Con frecuencia escuchamos que los alumnos de hoy en día cada vez saben menos y están peor formados, que la educación ya no es lo que era, que los valores tradicionales del esfuerzo y respeto se están perdiendo...y así un listado innumerable de sentencias poco alentadoras (Pozo y cols., 2006).

Los resultados de algunas de las pruebas internacionales más populares tampoco parecen acompañar demasiado (OCDE 2014a, 2014b). Por ejemplo, el Programa Internacional para la Evaluación de los Alumnos (PISA, por sus siglas en inglés) realizado en 2012 señala que España obtiene resultados por debajo de la media de los países de la OCDE en matemáticas, lectura y ciencia, a pesar de haber incrementado en un 35% el gasto en educación desde 2003. Los indicadores sobre equidad también son negativos, mostrando un retroceso durante el mismo periodo.

---

<sup>1</sup> Este capítulo está parcialmente publicado en:

Pozo, J.I. y de Aldama, C. (2013). A mudança nas formas de ensinar e aprender na era digital, *Patio*, 10-14.

El Estudio Internacional de la Enseñanza y el Aprendizaje (TALIS en sus siglas en inglés), realizado también por la OCDE en 2013, aporta información muy relevante en relación con el desempeño y satisfacción del profesorado, equipos directivos y centros escolares. En él se afirma que, a pesar de que en general los profesores se encuentran satisfechos tanto con la labor de sus centros como con su profesión docente, la mayoría considera que su profesión no está suficientemente valorada. El informe también revela que una gran parte del colectivo (61,5%) percibe que no tiene oportunidades suficientes para un desarrollo profesional adecuado.

A pesar de que este análisis ofrece una visión parcial y algo miope de la realidad (para profundizar ver Pozo, 2016), se trata de argumentos que suponen el caldo de cultivo para la emergencia de voces proponiendo toda suerte de soluciones<sup>2</sup>. La permanente sensación de crisis que parece azotar nuestro sistema educativo, así como en muchos casos las voces que se alzan con sugerencias para resolver esa situación, hunden sus raíces en un entramado, a menudo implícito y algo confuso, de creencias y concepciones sobre lo que pensamos que debe ser la educación (Pérez-Echeverría, Mateos, Pozo y Scheuer, 2001; Pozo et al., 2006; Scheuer y Pozo, 1999). Esas creencias y concepciones, en muchas ocasiones reflejo de nuestras propias experiencias y vivencias como aprendices, responden a una representación de la educación cuyo sentido pertenece más bien a otra época.

La escuela, en tanto en cuanto institución legitimada socialmente para transmitir los valores y conocimientos imprescindibles con los que todo ciudadano debe contar, se organiza y articula en un momento histórico-la modernidad de fines del siglo XVIII y XIX-en torno a una idea de cultura pública y con el predominio del pensamiento racional, reflexivo y argumentativo (Dussel, 2011) que, añade Pérez-Gómez (2012) *“respondía a las exigencias del mundo laboral en gran medida ordenado en torno a la fábrica y la cadena de montaje”* (p.71).

En la actualidad, la demanda social no se corresponde con el sentido original por el cual nació la escuela. Hoy, en una sociedad en continua transformación, urge más que nunca una reflexión serena y pausada sobre los nuevos retos y desafíos educativos del siglo XXI.

### **2.1. Nuevos retos y desafíos en la Educación del s.XXI: “ser (competente) o no ser, esa es la cuestión”**

Hoy no hay nada más cierto y estable que la realidad del cambio como parte de nuestro día a día. Los datos son abrumadores: en dos años se produce más información que en toda la historia anterior de la humanidad (Pérez-Gómez, 2012), aproximadamente cada año se duplica la cantidad de información disponible, mientras que hasta comienzos del siglo XX ese incremento se daba cada 100 años (Shank, 2015), ya en el 2005 según George Siemens el 50% de nuestros conocimientos nos eran desconocidos tan sólo 10 años antes (Siemens, 2005), etc.

Parece evidente que en una sociedad sometida a tales transformaciones las demandas y finalidades educativas sean otras a las que correspondían en el pasado, en una época, como

---

<sup>2</sup> Algunos autores como Arturo Pérez Reverte (ver <http://www.perezreverte.com/articulo/noticias-entrevistas/387/perez-reverte-soy-jacobino-creo-en-una-educacion-ferrea-y-medieval/>, consultado el 14 de mayo de 2016) o Ricardo Moreno en su *Panfleto Antipedagógico* (Moreno, 2006) proponen como solución regresar a un modelo donde “la letra con sangre entra”.

señala Pérez-Gómez (2012), donde la información que manejaban las personas permanecía prácticamente inalterable durante generaciones. Ya no tiene sentido, por tanto, acumular saberes y conocimientos rígidos e inalterables, sino más bien deben suponer un medio para transformar la mente del alumno (Pozo, 2016).

En este sentido, en una línea similar al proyecto DeSeCo-*Definition and Selection of Competencies*-de la OCDE, Voogt y Knezek (2008) describen cuáles son las competencias y habilidades necesarias para responder a las demandas de esta nueva Sociedad del Conocimiento, así como las estrategias de aprendizaje que se deben desarrollar para adquirirlas. La Tabla 2.1 resume los aspectos más relevantes:

**Tabla 2.1.** *Relación entre las demandas de la Sociedad del Conocimiento, las habilidades y competencias requeridas y las estrategias de aprendizaje (adaptado de Voogt y Knezek, 2008).*

<b>Demandas de la sociedad</b>	<b>Habilidades requeridas</b>	<b>Estrategias de aprendizaje</b>
Conocimiento como mercancía	Construcción del conocimiento	Investigación, aprendizaje basado en proyectos, constructivismo
Rápidas transformaciones, renovación	Adaptabilidad	Aprender a aprender, aprendizaje basado en la demanda
Explosión informativa	Selección, organización, recuperación de la información; competencia <i>informacional</i> <sup>3</sup> en el uso de las TIC	Tratamiento <i>estratégico</i> de múltiples bases de datos
Información pobremente organizada	Gestión de la información, competencia <i>informacional</i> en el uso de las TIC	Diseño de bases de datos e implementación
Información sesgada	Pensamiento crítico	Evaluación de resolución de problemas
Colectivización del conocimiento	Trabajo en equipo	Aprendizaje colaborativo

Según estos autores la Sociedad del Conocimiento se basa fundamentalmente en la producción e intercambio masivo de información desestructurada que procede de fuentes con intereses muy diversos. La globalización y participación conjunta en la producción del conocimiento aumenta vertiginosamente la velocidad del cambio. En este escenario, el individuo debe ser flexible y permeable, pero a la vez crítico y riguroso para no zozobrar en la abundancia y “el ruido informativo”. Transitar sin perecer por las arenas movedizas del conocimiento exige, por lo tanto, la adquisición de procedimientos de selección, organización, jerarquización y análisis de la información, en un proceso de *alfabetización informacional* (Coll y Monereo, 2008). Es por este motivo por el que Pérez-Gómez (2012) sugiere, para hacer frente satisfactoriamente a estas demandas, el aprendizaje de competencias de segundo orden tales como *aprender a aprender* o la *autorregulación del propio aprendizaje*, en vez de aprender, como fin en sí mismo, contenidos rígidos y estables.

<sup>3</sup> La *letra cursiva* es añadida por el autor de este documento.

Como señala Martín (2008), aprender a aprender supone tomar conciencia de las necesidades y procesos del propio aprendizaje, identificar las oportunidades, las limitaciones y obstáculos con el fin de tomar las decisiones más ajustadas. Exige adquirir procedimientos de análisis y evaluación de nuevos conocimientos que permitan su generalización a contextos diversos. En otras palabras, se trata de apropiarse de recursos útiles para desenvolverse eficazmente en los múltiples, complejos e inestables escenarios en los que diariamente nos movemos.

Las TIC, como apunta Monereo (2005), son un entorno favorable para el desarrollo de éstas y otras competencias. En primer lugar porque se trata de un medio de socialización “natural” para los jóvenes que, como señala un informe elaborado por el Ministerio del Interior del Gobierno de España (2014), llegan a pasar más de tres horas al día delante de una pantalla<sup>4</sup>. Delante de ella, aman, discuten, comparten y por supuesto, también aprenden. En segundo lugar, por su propia estructura y naturaleza. El acceso a una fuente inagotable de voces que dialogan en continuo movimiento permite contrastar, argumentar y tomar conciencia de las múltiples perspectivas. La Tabla 2.2 recoge las características más relevantes de estos entornos virtuales para el desarrollo de las competencias según Monereo (2005):

**Tabla 2.2. Entorno virtual y competencias básicas (Monereo, 2005)**

<b>Competencias sociocognitivas</b>	<b>Características del entorno virtual</b>
Aprender a buscar información y a aprender	Desarrolla estrategias de búsqueda y selección
Aprender a comunicarse	Asiste a la decodificación de mensajes Ayuda a la comunicación multimedial Beneficia la aparición de estrategias de lectura, habla y escritura
Aprender a colaborar con otros	Refuerza las habilidades cooperativas Facilita el aprendizaje entre iguales Suscita identidad y cohesión
Aprender a participar en la vida pública	Alienta a la participación pública Estimula el contraste de opiniones y argumentación Origina comportamientos solidarios Despliega el perspectivismo conceptual y emocional Favorece el autoconcepto y autoestima Apoya la definición de proyectos personales

Sin embargo, que las TIC y los entornos virtuales sean escenarios favorables para el desarrollo de esas competencias, no garantiza que por el mero hecho de utilizarlas vayamos a tener éxito. Muy al contrario, muchos son los ejemplos que alertan sobre las consecuencias

<sup>4</sup> En dicho informe el 22,5% de los jóvenes consultados entre 10 y 17 años dedicaban más de tres horas al día a navegar por internet. La frecuencia más habitual era entre una y dos horas al día, frecuencia que correspondía al 41, 9% de los encuestados. En estudios más recientes se destaca la universalidad del uso de las TIC por parte de la población española comprendida entre los 10 y 15 años, de tal forma que el 95,1% cuenta con un ordenador y el 93,6% utiliza Internet (INE, 2015). Publicado también recientemente, la Asociación para la Investigación de los Medios de Comunicación (AIMC, 2015) señala que el 61% de los niños entre 4 y 13 años se ha conectado a Internet en un mes promedio a lo largo de 2015 y que el 90% de los jóvenes menores de 34 años lo ha hecho a lo largo de un día promedio del 2016 (AIMC, 2016).

negativas de una mala praxis, como pueden ser las adicciones (Beranuy, Oberst, Carbonell y Chamarro, 2009) o el ciberbullying (Baldry, Farrington y Sorrentino, 2016).

En el próximo apartado reflexionamos acerca de la medida en la que la introducción de las TIC en contextos educativos está respondiendo a las demandas de la Sociedad del Conocimiento del s. XXI.

## 2.2. ¿Responden las TIC a las demandas de la Educación del s.XXI?

Como ya he tratado de justificar previamente, la introducción y generalización del uso de las TIC, por sus propias características (ver Tabla 2.3), favorece la rápida transformación de la sociedad en la que vivimos, generando nuevos retos y desafíos en todas las esferas de lo humano: una economía globalizada basada en el libre mercado donde bienes y personas circulan de forma vertiginosa (hoy en día vemos en un aeropuerto cualquiera más gente de la que se veía hace apenas unos siglos en toda la vida), nuevas formas de poder y distribución de la riqueza que desembocan en nuevos movimientos sociales y políticos<sup>5</sup>, transformaciones profundas de instituciones hasta hace poco incuestionables como la familia, e incluso cierto atisbo de cambio, inimaginable hasta hace poco, en otras como la Iglesia católica<sup>6</sup>....

**Tabla 2.3.** Características de las TIC (Badía, 2006; Coll y Martí., 2001; Martí, 2003)

<b>Formalismo</b>	Forma u organización de las informaciones y su tratamiento
<b>Interactividad</b>	Posibilidad de establecer una relación recíproca entre el usuario y las informaciones
<b>Dinamismo</b>	Posibilidad de presentar en toda su complejidad diferentes procesos espacio-temporales
<b>Multimedia</b>	Posibilidad de combinar diferentes medios simbólicos clásicos (imagen, sonido, escritura, números)
<b>Hipermedia</b>	Forma organizada no lineal en la que se presentan muchas de las informaciones
<b>Almacenamiento</b>	Posibilidad de almacenar y organizar grandes cantidades de información
<b>Transmisión</b>	Posibilidad de transmitir información con facilidad

Como ya he señalado anteriormente, los sistemas educativos deben dotar a los individuos de herramientas suficientes como para poder desenvolverse de forma plena y autónoma en un contexto tan complejo e incierto como este. Para ello no basta con transmitir los saberes y valores rígidos e incuestionables del pasado. Es necesario cambiar los escenarios

<sup>5</sup> El movimiento 15M, del cual se acaba de cumplir el 5º aniversario, es una de las movilizaciones sociales más relevantes de los últimos tiempos en nuestro país, donde los entornos virtuales, como las redes sociales, tuvieron una importancia capital (para profundizar se puede consultar <http://15mpedia.org/wiki/Portada>)

<sup>6</sup> Aunque esta es una de las instituciones que históricamente ha evolucionado con mayor lentitud, es cuanto menos sorprendente e inimaginable hace apenas unos años algunas de las cuestiones que están sobre la mesa, como la posibilidad de que las mujeres también oficien misas [http://en.radiovaticana.va/news/2016/05/12/pope\\_calls\\_for\\_commission\\_to\\_study\\_reinstating\\_women\\_deacons/1229409](http://en.radiovaticana.va/news/2016/05/12/pope_calls_for_commission_to_study_reinstating_women_deacons/1229409)

instruccionales, las prácticas de enseñanza y aprendizaje para favorecer el desarrollo de personas flexibles y capaces de adaptarse a situaciones muy inestables<sup>7</sup>.

La cuestión que ahora planteo es en qué medida la introducción de las TIC en los contextos educativos, especialmente en aquellos espacios formales como la escuela o la universidad, están modificando las prácticas de enseñanza y aprendizaje de forma coherente con las nuevas demandas sociales. Se trata de una pregunta cuya respuesta ni es sencilla ni está exenta de múltiples posiciones y perspectivas. Existen voces *optimistas* que apuestan entusiastamente por el uso de las TIC en las aulas, y otras, que al contrario, se muestran *pesimistas* y creen que la gestión de la información digital, por su inmediatez, superficialidad y falta de reflexión, supone un empobrecimiento de las formas de pensar y conocer. Entre medias de las dos, nos encontramos aquellos *escépticos*, que analizando no lo que debe ser sino lo que realmente ha sucedido hasta ahora, observan que las TIC apenas han tenido impacto.

A continuación repaso brevemente los argumentos que defienden cada una de estas tres posiciones (optimista, pesimista y escéptica).

### 2.2.1. El argumento optimista: las TIC como herramientas de transformación

Hay quienes apuestan entusiastamente por el papel transformador de las TIC en las formas de enseñar y aprender, apoyándose en la idea de que la interacción con esas tecnologías resulta muy atractiva para los adolescentes actuales, que, según la afortunada expresión de Prensky (2001), son verdaderos *nativos digitales*, que han naturalizado ya el uso de esas tecnologías, más sensibles a las necesidades del alumno, de manera que su interés y competencia en el uso de la información y el conocimiento ha aumentado. Los principales avances introducidos por las TIC serían (de Aldama, 2012; Coll y Monereo, 2008; Collins y Halverson, 2009):

1. Adaptación al aprendiz: la inmensa cantidad de información y recursos disponibles en la red permiten al usuario seleccionar aquella información que más se ajusta a sus intereses y necesidades, lo que favorece la autorregulación y control del propio aprendizaje. Es decir, el aprendiz decide el qué, cómo y cuándo aprender.
2. Interacción: las TIC favorecen un escenario dialógico, donde cada acción del aprendiz puede ser acompañado de un feedback. Es decir, un buen uso de estas tecnologías permite al usuario tomar conciencia de sus propios actos (función metacognitiva).
3. Andamiaje: uno de los problemas más frecuentes en la enseñanza tradicional es que el aprendiz no encuentre significado a la tarea, ya sea porque se sitúe muy por debajo o muy por encima de su zona de desarrollo próximo. Las TIC permiten brindar las ayudas adecuadas a cada aprendiz en cada momento.
4. Juegos y simulación: las TIC permiten simular escenarios de aprendizaje real, a la vez que reducen las consecuencias negativas que pudieran darse en ese contexto.
5. Multimedia: gracias a las nuevas tecnologías, el conocimiento elaborado en las aulas pasa de un formato impreso (propio de la enseñanza tradicional) a un formato multimedia, aumentando considerablemente las formas de expresión y comunicación.

---

<sup>7</sup> Hoy es más necesaria que nunca poner en práctica aquella afirmación de Bruce Lee, conocido actor y maestro de artes marciales, que se hizo tan famosa en un anuncio publicitario: "be water, my friend". (se puede ver en <https://www.youtube.com/watch?v=TQ683zlrUSI>).



6. Publicación: en las aulas tradicionales los alumnos consumen información o, en el mejor de los casos, producen algún contenido que sólo el docente supervisará. Las TIC permiten mostrar creaciones propias y originales a una audiencia real.

### *2.2.2. El argumento pesimista: las TIC y el empobrecimiento de los procesos de enseñanza y aprendizaje*

Desde una óptica completamente opuesta a la anterior, los pesimistas mantienen que la interacción con la información en la era digital supone un empobrecimiento de las formas de conocer ya que se promueve la inmediatez, la superficialidad y la falta de reflexión, como reflejan en muchos casos los intercambios en las redes sociales (por ej., Carr, 2011). En este sentido, los argumentos esenciales a favor de esta posición serían (ver de Aldama, 2012; Carr, 2011, Collins y Halverson, 2009; Haythornthwaite y Nielsen, 2007):

1. Empobrecimiento cognitivo en la era digital. Los alumnos se están acostumbrando a un acceso inmediato a la información, que no requiere de ellos un proceso de reflexión y construcción personal. Además, a menudo realizan varias tareas a la vez, lo que impide un procesamiento elaborado de la información.
2. Como consecuencia de lo anterior, en muchas ocasiones los conocimientos y saberes transmitidos y comunicados son inestables y de baja calidad
3. Gestión del aula: Son frecuentes las dificultades en la gestión del aula al introducir las TIC como consecuencia de la escasez de recursos (en casi todos los casos los alumnos deben compartir los ordenadores) y pérdida del control sobre las tareas que los alumnos realizan.
4. Los ordenadores no pueden enseñarlo todo: las nuevas tecnologías son dispensadoras de contenidos que en ningún caso podrán llegar a enseñar todo lo necesario. Los aprendizajes sociales y actitudinales tienen que estar mediados por el docente.
5. Autoridad y enseñanza: algunos docentes, acostumbrados a que su autoridad repose sobre los conocimientos y sabiduría que comparten con sus alumnos, se sienten amenazados al ver que las TIC cumplen sus funciones. Si antes el único conocimiento legítimo que emergía en un aula era el que dispensaba el docente, en la actualidad la información y sus fuentes se multiplican casi indefinidamente. Estos condicionantes suponen un reto y esfuerzo añadido para los docentes, obligados a menudo a modificar sus modelos de enseñanza e instrucción.

### *2.2.3. El argumento escéptico: sin rastro del cambio*

Entre medias de las dos posiciones anteriores, podemos encontrar una tercera visión, más escéptica o incrédula, según la cual los cambios no son ni positivos ni negativos, sencillamente apenas ha habido cambios: las formas de enseñar y aprender en la era digital son las mismas que han predominado siempre en la escuela, pero modificando el soporte cuando se introducen las TIC en el aula.

Según esta perspectiva lo que ha cambiado es la naturaleza de la información, ahora más dinámica e incierta (Pozo, 2014), lo que genera, no un empobrecimiento de las formas de aprender y conocer (como sostienen aquellos más pesimistas), si no dificultades en cuanto a la gestión del conocimiento. Estas afirmaciones se apoyan en datos como los obtenidos por el

informe PISA, tanto en la edición del 2009 (Instituto de Evaluación, 2010) como en la del 2012 (Instituto Nacional de Evaluación Educativa, 2013), donde el rendimiento de los alumnos españoles en lectura digital es claramente inferior a la lectura impresa.

En concreto, entre las deficiencias detectadas (ver también Coll y Monereo, 2008) estarían:

1. Estrategias de selección de la información: los alumnos no saben buscar y seleccionar la información relevante, dejándose llevar por el propio flujo y formato en que se presenta.
2. Traducción de la información de unos códigos a otros: tienen dificultades cuando la información se presenta en códigos diferentes (texto, imágenes, etc.) y es necesario traducirla de unos a otros.
3. Integración de diferentes fuentes y tipos de información: más allá de esa dificultad de traducción tiene problemas cuando se encuentran con informaciones diversas o contradictorias, como frecuentemente sucede en los espacios virtuales, donde no hay nunca un saber cerrado y establecido.
4. Tendencia a reproducir más que a reflexionar sobre la información encontrada: en el mejor de los casos cuando se encuentran con informaciones diversas tienden a usar el “recorta y pega” más que intentar a construir su propia visión que integre esas diversas posiciones.

#### *2.2.4. Entonces....¿pueden las TIC responder a los desafíos de la Educación del s. XXI?*

Hasta el momento he descrito de forma sucinta las diferentes perspectivas y los argumentos correspondientes que podemos encontrarnos en relación con las TIC como herramientas educativas. La cuestión que ahora toca responder es, teniendo en cuenta las diferentes posiciones, hasta qué punto las TIC ofrecen posibilidades a los sistemas educativos para dar respuesta a las nuevas demandas sociales.

Describir de forma precisa y con todos los matices cuál ha sido el impacto de las TIC sobre los procesos de enseñanza y aprendizaje en los diversos contextos instruccionales es una tarea de tal complejidad, como señalan algunos trabajos (Tamim, Bernard, Borokhovski, Abrami y Schmid, 2011), que escapa con mucho los objetivos de esta tesis. Asumiendo esta limitación, y aún a riesgo de caer en argumentos reduccionistas, la realidad parece dar la razón a los más escépticos, si atendemos a los resultados de las últimas investigaciones (Coll y Monereo, 2008; Lim, Zhao, Tondeur, Chai y Tsai, 2013; Price y Kirkwood, 2014). Así, desde los estudios ya clásicos de Cuban y colaboradores en Estados Unidos (Cuban, 1993, 2001; Cuban, Kirpatrick y Peck, 2001), pasando por los trabajos dentro del marco de la Unión Europea, como el *European Survey of Schools: ICT in Education* (Schoolnet, 2013; Wastiau et al. 2013), o aquellos en clave nacional (ONTSI, 2014; Sigalés, Mominó, Meneses y Badía, 2008), revelan que los usos más sofisticados de las TIC en las aulas, como la creación de contenidos multimedia, la reflexión sobre la multimodalidad o el acceso a procedimientos complejos de producción y comunicación del conocimiento, continúan lejos de ser una práctica generalizada (Dussel, 2011). Por ejemplo, si analizamos los datos facilitados por el ESSIE (Schoolnet, 2013) se observa que los docentes de secundaria todavía tienen dificultades para integrar diariamente las TIC en el aula (el mejor de los casos, sólo uno de cada cuatro profesores las

utiliza cada día para preparar actividades para sus alumnos). Por otro lado, la frecuencia de uso depende en gran medida de la naturaleza de la actividad, siendo la dimensión informativa la que más se trabaja en detrimento de la comunicación. Además, la forma en la que se gestiona esa información es eminentemente transmisiva y centrada en el contenido (Sigalés, Mominó, Meneses y Badía, 2008). Así, actividades como evaluar o dar feedback a los alumnos a través de las TIC son prácticamente inexistentes (tan sólo uno de cada cuatro profesores las utilizan alguna vez con este objetivo). Los datos aportados por el *Observatorio Nacional para las Telecomunicaciones y la Sociedad de la Información* (ONTSI, 2014) son coherentes con estas afirmaciones, de forma que tan sólo el 15,1% y el 10,3% de los profesores españoles utilizan las TIC para evaluar y comunicarse con sus alumnos respectivamente.

Según Pozo (2008, 2014, 2016), en una sociedad donde los alumnos a menudo están tecnológicamente mejor alfabetizados que los profesores, es necesario una nueva cultura educativa que permite una verdadera transformación de la información en conocimiento, es decir, que favorezca la *alfabetización informacional* de sus ciudadanos. Una cultura que implique un uso de las TIC no para reproducir los viejos hábitos de una enseñanza y aprendizaje transmisivos, sino para fomentar nuevas formas de aprender y enseñar donde el docente sea el mediador de un diálogo que trascienda el aula para incorporar los nuevos espacios de conocimiento abiertos por las TIC. En concreto, las formas de gestionar la información a través de las TIC deberían ayudar a promover tres cambios esenciales en las formas de enseñar y aprender:

1. El paso de una epistemología realista centrada en la transmisión de conocimientos “verdaderos”, cerrados, a una gestión de la incertidumbre más propia de los tiempos actuales. Si como señalara Morin (1999) conocer y saber hoy no es apropiarse de verdades sino gestionar la incertidumbre propia de estos tiempos, las TIC deben ser una herramienta esencial para dotar a los alumnos de competencias para navegar en esa incertidumbre.
2. De una gestión unidireccional del conocimiento (monológica) a una gestión multidireccional (dialógica). Debemos de pasar de unas aulas en las que sólo se oye la voz del conocimiento establecido (en la voz del docente o del libro de texto) a un espacio dialógico, pero basado en un diálogo muy distinto del que se produce en las redes sociales. Aquí no se trata de intercambiar opiniones, sino de construir argumentos y conocimientos a través de un diálogo mediado por el docente.
3. De representaciones estáticas y proposicionales apoyadas por “ilustraciones” a la integración dinámica de múltiples sistemas de representación. A diferencia de los sistemas más tradicionales, las TIC permiten que quien interactúa con la información no sólo la reciba, sino que la transforme, genere nuevas representaciones y conocimientos compartidos, basados en múltiples códigos distribuidos tanto en el espacio como en el tiempo, lo que nos acerca a la idea del aprendiz como constructor de su propio conocimiento.

Pero sabemos que para que estos cambios se produzcan no sólo es necesario disponer de estos recursos tecnológicos en las aulas, que sería una primera barrera (Ertmer, 1999), sino cambiar la forma en que profesores y alumnos conciben su uso y sus funciones, en suma cambiar sus mentalidades o concepciones de enseñanza y aprendizaje (Pozo *et al.*, 2006). Desde una visión tradicional o directa, en la que la función de la educación es transmitir a los

alumnos saberes establecidos, bien definidos, el impacto de las TIC se reduce a cambiar el soporte de la práctica docente en lugar de transformarla (de Aldama, 2012). Sin embargo, sí creemos que el conocimiento no es un fin en sí mismo sino el medio para construir competencias en los alumnos, para dotarles de estrategias para convertir la información en conocimiento, entonces las TIC constituyen no sólo herramientas extraordinariamente potentes, sino un nuevo espacio desde el que construir una nueva cultura de aprendizaje en nuestras aulas.

Siendo consciente de que las concepciones y creencias sobre la enseñanza y el aprendizaje de profesores y alumnos no son suficientes para explicar en su totalidad el complejo fenómeno de la integración de las TIC en contextos educativos<sup>8</sup>, en el siguiente capítulo tratamos de profundizar en su conceptualización teórica.

## Referencias

- de Aldama C. (2012) *Concepciones del profesorado sobre los usos de las TIC en contextos educativos*, Trabajo de Fin del Master Oficial en Psicología de la Educación, Facultad de Psicología, Universidad Autónoma de Madrid. Documento no publicado
- Asociación para la Investigación de Medios de Comunicación-AIMC (2015). Resultados de la 3ª ola del Estudio General de Medios (EGM) 2015. Disponible en <http://www.aimc.es/Entrega-de-resultados-EGM-3%C2%AA-ola,1696.html>, consultado el 19 de Mayo de 2016
- Asociación para la Investigación de Medios de Comunicación-AIMC (2016). Resultados de la 1ª ola del Estudio General de Medios (EGM) 2016. Disponible en <http://www.aimc.es/Entrega-de-resultados-EGM-1%C2%AA-ola,1768.html>, consultado el 19 de Mayo de 2016
- Badia, A. (2006). Ayuda al aprendizaje con tecnología en la educación superior. *Revista de Universidad y Sociedad del Conocimiento*, 3(2), 5-19.
- Baldry, A. C., Farrington, D. P., y Sorrentino, A. (2016). Cyberbullying in youth: A pattern of disruptive behaviour. *Psicología Educativa*.
- Beranuy, M., Oberst, U., Carbonell, X., y Chamarro, A. (2009). Problematic Internet and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. *Computers in human behavior*, 25(5), 1182-1187.
- Carr, N. (2011). *Superficiales.¿ Qué está haciendo Internet con nuestras mentes?* Madrid: Taurus.
- Coll, C. y Martí, E. (2001). La educación escolar ante las nuevas tecnologías de la información y la comunicación. En C. Coll, J. Palacios, Á. Marchesi (comps.). *Desarrollo psicológico y educación*. Psicología de la educación escolar. Madrid: Alianza Editorial. Pág. 623-651.
- Coll, C., y Monereo, C. (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Collins, A. y Halverson, R. (2009). *Rethinking education in the age of technology. The digital evolution and schooling in America*. N. York: Teachers College Press

---

<sup>8</sup> Es interesante citar al respecto el trabajo realizado por Enguita (2013), donde, comparando resultados obtenidos de las pruebas ESSIE (2013) y TALIS (2013), concluye que el factor más relevante a la hora de integrar las TIC en las aulas, más que el propio enfoque pedagógico de los docentes, es el liderazgo del equipo directivo.

- Coolahan, J. (2002), "Teacher Education and the Teaching Career in an Era of Lifelong Learning", *OECD Education Working Papers*, No. 2, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/226408628504>
- Cuban, L. (1993). *Computers meet classroom: classroom win*. Teachers College Record, 95(2), págs. 185-210.
- Cuban, L. (2001). *Oversold & Underused. Computers in the Classroom*. Cambridge, MA, Harvard University Press.
- Cuban, L., Kirpatrick, H. y Peck, C. (2001). High access and low use of technologies in high school classrooms: explaining an apparent paradox. *American Educational Research Journal* 38 (4), 813-834
- Dussel, I. (2011). *Aprender y enseñar en la cultura digital*. VII foro Latinoamericano de educación. Buenos Aires: Santillana
- Ertmer, P. (1999). Addressing first-and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development*, 47 (4), 47-61
- Haythornthwaite, C., y Nielson, A. L. (2007). Revisiting computer-mediated communication for work, community, and learning. En J. Gackenbach (Ed.). *Psychology and the Internet: Intrapersonal, interpersonal, and transpersonal implications*, p.167-185, Academic Press.
- Instituto de Evaluación-IE (2010). *PISA 2009. Programa para la evaluación internacional de los alumnos. Informe español*. Madrid: Ministerio de Educación
- Instituto Nacional de Estadística-INE (2015). Encuesta sobre Equipamiento y Uso de Tecnologías de Información y Comunicación en Hogares. Año 2015. Documento disponible en: [http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica\\_C&cid=1254736176741&menu=ultiDatos&idp=125473597660](http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176741&menu=ultiDatos&idp=125473597660), consultado el 18 de Mayo de 2016
- Instituto Nacional de Evaluación Educativa-INEE (2013). *PISA 2012. Programa para la evaluación Internacional de los alumnos. Informe español*. Madrid: Ministerio de Educación, Cultura y Deporte
- Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education*, 14, 581-597.
- Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S., y Tsai, C. C. (2013). Bridging the Gap: Technology Trends and Use of Technology in Schools. *Educational Technology & Society*, 16(2), 59-68.
- Martí, E. (2003). *Representar el mundo externamente. La construcción infantil de los sistemas externos de representación*. Madrid: Machado Libros
- Martín, E. (2008). Aprender a aprender: clave para el aprendizaje a lo largo de la vida. *Participación Educativa*, 9, 77-83
- Ministerio del Interior del Gobierno de España (2014). *Encuesta sobre hábitos de uso y seguridad de Internet de menores y jóvenes en España*, consultado en <http://www.interior.gob.es/documents/10180/2563633/Encuesta+sobre+h%C3%A1bitos+de+uso+y+seguridad+de+internet+de+menores+y+j%C3%B3venes+en+Espa%C3%B1a/b88a590a-514d-49a2-9162-f58b7e2cb354>. el 18 de mayo de 2016
- Monereo, C. (2005). Internet un espacio idóneo para desarrollar las competencias básicas. En Monereo et al, *Internet y competencias básicas. Aprender a colaborar, a comunicarse, a participar, a aprender* (pp. 5-25). México: Graó.
- Moreno, R. (2006). *Panfleto antipedagógico*. Barcelona, Lector universal.
- Morin, E. (1999) *La mente bien ordenada*. Barcelona: Seix Barral, 2000

- OECD. (2014a), "Spain", in OECD. , *PISA 2012 Results: What Students Know and Can Do (Volume I, Revised edition, February 2014): Student Performance in Mathematics, Reading and Science*, OECD Publishing, Paris.  
DOI: <http://dx.doi.org/10.1787/9789264208780-20-en>
- OECD. (2014b), *Guía del profesorado TALIS 2013: Estudio internacional sobre enseñanza y aprendizaje*, OECD Publishing, Paris.  
DOI: <http://dx.doi.org/10.1787/9789264221932-es>
- Observatorio Nacional para las Telecomunicaciones y la Sociedad de la Información-ONTSI (2014). *Las TIC en el aula*, documento disponible en [http://www.ontsi.red.es/ontsi/sites/default/files/las\\_tic\\_en\\_el\\_aula.pdf](http://www.ontsi.red.es/ontsi/sites/default/files/las_tic_en_el_aula.pdf), consultado el 23 de Febrero de 2015
- Pérez-Echeverría, M. P., Mateos, M., Pozo, J. I., y Scheuer, N. (2001). En busca del constructivismo perdido: concepciones implícitas sobre el aprendizaje. *Estudios de psicología*, 22(2), 155-173.
- Pérez-Gómez, M.A. (2012). *Educarse en la era digital*. Madrid: Morata
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J. I. (2014). *Psicología del Aprendizaje Humano: Adquisición de conocimiento y cambio personal*. Madrid: Morata
- Pozo, J. I. (2016). *Aprender en tiempos revueltos: la nueva ciencia del aprendizaje*. Madrid: Alianza
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., y de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.
- Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon*, 9(5), 1-6.
- Price, L y Kirkwood, A. (2014). Using technology for teaching and learning in higher education: a critical review of the role of evidence in informing practice. *Higher Education Research and Development*, 33(3) pp. 549–564
- Roehrig, G. H., Kruse, R. A., y Kern, A. (2007). Teacher and school characteristics and their influence on curriculum implementation. *Journal of Research in Science Teaching*, 44, 883–907.
- Scheuer, N., y Pozo, J. I. (1999). Las concepciones sobre el aprendizaje como teorías implícitas. In *El aprendizaje estratégico: enseñar a aprender desde el currículo* (pp. 87-108). Santillana.
- Schoolnet, E. (2013). Survey of Schools: ICT in Education. Benchmarking Access, Use and Attitudes to Technology in European Schools. *Liège: European Union. doi, 10, 94499*.
- Shank, P. (2015). Science of Learning 101: Are we doing the right things? Consultado el 16 de mayo de 2016 en <https://www.td.org/Publications/Blogs/Science-of-Learning-Blog/2015/06/Science-of-Learning-101-Are-We-Doing-the-Right-Things>
- Sigalés, C., Mominó, J.M<sup>a</sup>., Meneses, J. y Badia, A. (2008). *La integración de internet en la educación escolar española: situación actual y perspectivas de futuro*. Informe de investigación elaborado con la colaboración de la UOC y Fundación Telefónica.
- Siemens, G. (2005). Connectivism: Learning as network-creation. *ASTD Learning News*, 10(1).
- Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., y Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning: A

second-order meta-analysis and validation study. *Review of Educational Research*, 81, 4–28.

Voogt, J., y Knezek, G. (Eds.). (2008). *International handbook of information technology in primary and secondary education* (Vol. 20). Springer Science & Business Media.

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., y Monseur, C. (2013). The use of ICT in education: a survey of schools in Europe. *European Journal of Education*, 48(1), 11-27.

### CAPÍTULO 3. CONCEPCIONES Y TEORÍAS IMPLÍCITAS: ALLANANDO EL TERRENO PARA UNA INTEGRACIÓN DE LAS TIC EN EL AULA

#### Resumen

Partiendo de la base de que las concepciones epistemológicas y educativas tienen una influencia fundamental sobre la forma en la que posteriormente nos comportamos en contextos instruccionales (Gopnik y Meltzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al. 2006), el presente capítulo profundiza en su conceptualización teórica, así como la función que desempeñan a la hora de apropiarnos de las TIC como herramientas de enseñanza y aprendizaje.

Los seres humanos nos desenvolvemos en el mundo sostenidos por concepciones y creencias, a menudo implícitas, sobre lo que consideramos que son las diferentes dimensiones de la realidad. Estas construcciones mentales, basadas en nuestra experiencia personal y fruto de una doble herencia tanto biológica como cultural (Tomasello, 1999), nos aportan en muchos casos representaciones bastantes eficaces sobre el mundo físico y social (Pozo, 2001; Pozo et al., 2006), de tal forma que a menudo se convierten en guía de nuestra acción y pensamiento (Brown y Cooney, 1982; Pajares, 1992; Siegel, 1985). Así, somos capaces de predecir el movimiento de un objeto cuando aplicamos una fuerza sobre él, de emocionarnos al leer un poema de Galeano o discutir sobre cuáles deben ser las medidas políticas a adoptar para salir de la crisis económica.

Como ya he señalado al comienzo del capítulo, la educación, los procesos de enseñanza y aprendizaje, el rol que deben jugar los diferentes agentes educativos, la forma en la que adquirimos el conocimiento, etc, no son ajenos a estas concepciones y creencias. Cuando Arturo Pérez Reverte sugiere que es necesario regresar a un modelo educativo “férreo y medieval” (Pozo, 2016), lo hace en base a ciertas construcciones mentales sobre lo que debe y no debe ser la educación, muchas de las cuales permanecen en un plano oculto para la conciencia. Esas construcciones mentales a menudo se agrupan de forma organizada y sistemática, conformando lo que algunos autores consideran verdaderas *teorías implícitas* (Gopnik y Melzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al. 2006). Para que se configuren como tales, el sistema de creencias y concepciones debe respetar y ser coherente con una serie de principios epistemológicos, ontológicos y conceptuales. Si uno de estos principios es violado, entonces la teoría se pone en entredicho, iniciando un proceso de revisión y, en caso necesario, de modificación (para profundizar en el proceso ver Pozo et al. 2006).

#### 3.1. Teorías implícitas: principios epistemológicos, ontológicos y conceptuales

Pérez-Echeverría et al. (2001) diferencian tres perfiles o posibles teorías implícitas sobre el aprendizaje. La Tabla 3 resume las principales características de cada una de ellas:

**Tabla 3.1.** *Teorías implícitas sobre el aprendizaje (Pérez-Echeverría et al., 2001)*



PRINCIPIOS	TEORÍA IMPLÍCITA		
	DIRECTA	INTERPRETATIVA	CONSTRUCTIVA
<b>EPISTEMOLÓGICOS</b> <i>¿Cuál es la relación entre el conocimiento y su objeto?</i>	<b>Realismo ingenuo</b> <b>Dualismo</b> El conocimiento refleja el objeto con fidelidad, aunque con diversos grados de plenitud o exhaustividad. Hay conocimientos parciales y conocimientos completos.	<b>Realismo interpretativo</b> <b>Pluralismo</b> El conocimiento refleja el objeto de manera algo borrosa o distorsionada. Esa distorsión puede reducirse, o incluso eliminarse mediante el empleo de técnicas adecuadas de detección, medición, contrastación, etc	<b>Constructivismo</b> <b>Relativismo</b> El conocimiento es una construcción elaborada en un contexto social y cultural en relación con ciertas metas. Esa construcción proporciona modelos tentativos y alternativos para interpretar el objeto, cada uno de ellos con diferentes niveles de adecuación según el contexto en que se apliquen y su potencia explicativa.
<b>ONTOLÓGICOS</b> <i>¿Qué clase de entidad es el aprendizaje?</i>	<b>Estados y sucesos</b> Los resultados del aprendizaje se conciben en términos de estados. La generación de esos resultados se concibe en términos de sucesos aislados y recortados.	<b>Procesos</b> Se concibe el aprendizaje en términos de procesos, que van aumentando en número y complejidad, determinados por diversos factores: evolutivos, cognitivos, motivacionales, etc.	<b>Sistemas</b> Se interpreta el aprendizaje a partir de relaciones complejas entre componentes que forman parte de un sistema que a su vez interactúa con otros sistemas.
<b>CONCEPTUALES</b> <i>¿Qué tipo de relaciones conceptuales hay entre los elementos que componen la teoría y cómo se estructura ésta?</i>	<b>Datos y hechos</b> Se establece una relación lineal y directa entre unas condiciones (edad, motivación, contacto con el objeto, etc.) y los resultados del aprendizaje.	<b>Causalidad lineal</b> <b>De simple a compleja</b> La eficacia del aprendizaje depende de una serie de factores que, por separado o sumados, actúan de modo unidireccional sobre los resultados.	<b>Interacción</b> Las interacciones entre el sistema de aprendizaje y los otros sistemas (psicológicos, educativos, sociales) en los que está inscrito, definen el marco de interpretación del aprendizaje.

Así, retomando el ejemplo utilizado anteriormente sobre el cambio climático, alguien que se aproximara a este fenómeno desde una teoría implícita directa, concebiría el problema como una realidad estática con entidad propia independientemente del sujeto que lo interpreta. Comprender el fenómeno dependería de la medida en la que uno se apropia

fielmente de los datos y hechos que lo componen: identificar causas, reconocer consecuencias, conocer niveles de contaminación, etc. Desde una teoría implícita interpretativa, el cambio climático se seguiría percibiendo como una realidad con entidad propia, pero que no es independiente del sujeto que lo percibe. Es decir, a la hora de comprender el fenómeno estarían influyendo factores psicológicos tales como la memoria o la percepción. Desde este punto de vista, el cambio climático se entiende como un proceso complejo donde múltiples variables interactúan entre sí. Por último, desde una perspectiva constructivista el cambio climático, al igual que cualquier otro objeto de conocimiento, se entendería como una construcción mental del individuo cognoscente. Esto no significa negar la existencia de una realidad, sino más bien entender que ésta se materializa a través de nuestras estructuras de conocimiento. En este sentido, el cambio climático se considera como un sistema hipercomplejo donde no solamente existen factores que interactúan entre sí, sino que además esos factores adquieren sentido y significados con matices relacionados, pero diferentes, entre individuos diversos.

### **3.2. Concepciones y teorías implícitas en relación con el uso educativo de las TIC**

Como ya he mencionado anteriormente, el uso de las TIC desde una visión tradicional o teoría implícita directa, donde la función educativa es transmitir una serie de conocimientos y valores bien definidos y estables, se reduce a perpetuar las mismas prácticas pero a través de nuevos medios. Una de las características de las TIC que más se aprovechan desde este enfoque es el supuesto poder que tienen para motivar al estudiante en su aprendizaje (Cox, 1997; Becta, 2003; Popoola, 2012). La idea que subyace es presentar el mismo contenido, relevante en el pasado, pero de una forma que resulte más atractiva para el alumno. Con ese objetivo, a menudo se diseñan materiales donde se combinan imágenes, videos y otros formatos multimedia para “acompañar o ilustrar” el verdadero objeto de conocimiento.

Siendo consciente de que caer en un determinismo pedagógico sería un grave error, existen datos suficientes como para afirmar que utilizar las TIC bajo principios próximos al constructivismo permiten responder en mejor medida a las necesidades sociales actuales (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, y Sendurur, 2012; Judson, 2006; Roehrig, Kruse y Kern, 2007; Prestridge, 2012)<sup>1</sup>. Así, Ertmer y Ottenbreit-Leftwich (2010) afirman que, en general, aquellos profesores con creencias más tradicionales implementan las TIC con usos de “bajo nivel”, mientras que aquellos que presentan creencias más constructivistas las integran a través de prácticas más centradas en el alumno o de “alto nivel”. De forma coherente, Kim, Kim, Lee, Spector y DeMeester (2013) hallaron una correlación de hasta .9 entre nivel de uso de las TIC y concepciones sobre la enseñanza, concluyendo, a pesar de la ausencia de causalidad, que las creencias epistemológicas determinan la toma de decisiones sobre cómo enseñar con o sin tecnología.

A pesar de que en general se aceptan estas conclusiones, también existen ejemplos donde se aprecian inconsistencias entre las creencias y los usos de las TIC. Por ejemplo, Liu (2011) encontró que, en la mayoría de los casos, los profesores de su muestra se sentían identificados con creencias constructivistas. Sin embargo, las prácticas informadas se

---

<sup>1</sup> Como pongo de manifiesto en el *Artículo II*, presentar concepciones coherentes con el constructivismo no garantiza desarrollar actividades que estén alineadas en el mismo sentido.

correspondían con modelos más tradicionales. Como afirma Prestridge (2012), las creencias pueden representar contextos ideales o situaciones deseables. Cuando la realidad del aula entra en contacto con nuestras concepciones, éstas no siempre informan de nuestra práctica (Albion y Ertmer, 2002).

En el próximo capítulo nos adentramos en el aula para describir los diferentes elementos involucrados, y las relaciones que se dan entre ellos, en un entorno mediado por las TIC, con el objetivo de profundizar en el conocimiento de su proceso de integración efectiva en contextos educativos.

#### Referencias

- Albion, P. R., y Ertmer, P. A. (2002). Beyond the foundations: The role of vision and belief in teachers' preparation for integration of technology. *TechTrends*, 46(5), 34.
- Becta (British Educational Communications and Technology Agency) (2003) *What the Research Says About ICT and Motivation*, Coventry: Becta.
- Brown, C. A., y Cooney, T. J. (1982). Research on Teacher Education: A Philosophical Orientation. *Journal of Research and Development in Education*, 15(4), 13-18.
- Cox, M. J. (1997). *The effects of information technology on students' motivation*. Coventry: Council for Educational Technology
- Ertmer, P. A., y Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of research on Technology in Education*, 42(3), 255-284.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423-435.
- Gopnik, A., y Melzoff, A. N. (1997). *Words, thoughts and theories*. Cambridge, MA: MIT Press.
- Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education*, 14(3), 581-597.
- Kim, C., Kim, M. K., Lee, C., Spector, J. M., y DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76-85.
- Liu, S. H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, 56(4), 1012-1022.
- Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332.
- Pérez-Echeverría, M. P., Mateos, M., Pozo, J. I., y Scheuer, N. (2001). En busca del constructivismo perdido: concepciones implícitas sobre el aprendizaje. *Estudios de psicología*, 22(2), 155-173.
- Popoola, O. (2012). *E-learning and motivation: a multi-faceted investigation of eleven to fourteen year olds' attraction to computer-based learning, and their motivational responses to the novelty and nature of a selection of self-study computer-based learning activities* (Doctoral dissertation, University of East Anglia).
- Pozo, J.I. (2001). *Humana mente: el mundo, la conciencia y la carne*. Madrid: Morata.

- Pozo, J. I. (2016). *Aprender en tiempos revueltos: la nueva ciencia del aprendizaje*. Madrid: Alianza.
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., y de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.
- Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & education*, 58(1), 449-458.
- Roehrig, G. H., Kruse, R. A., y Kern, A. (2007). Teacher and school characteristics and their influence on curriculum implementation. *Journal of Research in Science Teaching*, 44(7), 883-907.
- Siegel, H. (1985). What is the question concerning the rationality of science?. *Philosophy of Science*, 517-537.
- Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

## **CAPÍTULO 4. LAS TIC EN LA PRÁCTICA: HACIA UNA MEDIACIÓN DE LOS ELEMENTOS DEL TRIÁNGULO INTERACTIVO**

---

### **Resumen**

El capítulo que se presenta a continuación describe someramente el papel que deben jugar cada uno de los elementos del triángulo interactivo, es decir, docente, alumnos y contenido de aprendizaje, para una verdadera integración de las TIC como herramientas de enseñanza y aprendizaje.

Hasta el momento he tratado de justificar cómo la introducción y expansión de las TIC en nuestra realidad cotidiana ha favorecido y acelerado transformaciones sociales de enorme importancia. Esos cambios someten a nuestros sistemas educativos a una presión continua para que den respuesta a los nuevos retos y desafíos que emergen constantemente. Para poder adaptarse adecuadamente, los diferentes agentes educativos deben repensar sus funciones y finalidades, así como las prácticas a desarrollar donde, inevitablemente, las TIC juegan un papel muy relevante. Esto significa que el poder transformador de estas tecnologías digitales no emerge de forma espontánea como consecuencia de su mera introducción en las aulas. La materialización de sus posibilidades depende de la forma en la que estas herramientas median los procesos intra e inter psicológicos producto de la interacción entre los elementos del triángulo interactivo (Coll y Monereo, 2008).

Por este motivo, en este capítulo me centraré en identificar y describir el rol y las funciones de alumnos, profesor y contenido de aprendizaje en esta nueva cultura educativa adaptada a la Sociedad del Conocimiento.

### **3.1. El alumno en el s. XXI**

Como ya mencioné en el Capítulo 2, no son pocas las voces que alertan de la deriva de nuestras instituciones educativas, afirmando que se equivocan tanto en sus principios como en sus prácticas a la hora de formar a las generaciones más jóvenes. De éstos se dice en numerosas ocasiones que jamás han dedicado tantas horas a la laboriosa tarea de aprender y nunca han sido peores sus resultados. Pérdida de valores, ausencia de respeto hacia la autoridad, conocimientos superficiales, etc, son sólo algunos de los atributos con los que se les define desde ciertos sectores de la sociedad.

Un análisis serio y riguroso de la situación debe evitar reduccionismos y simplificaciones oportunistas que nos lleven a conclusiones precipitadas. Por eso mirar hoy con las lentes que utilizábamos ayer no parece lo más prudente.

Si algo ha cambiado en los últimos tiempos en la realidad de nuestras aulas son nuestros estudiantes y alumnos. Se trata de jóvenes para los cuales la tecnología es una extensión de su propio cuerpo (Monereo, 2004). Un dato anecdótico pero enormemente

gráfico: aplicaciones como Instagram o Whatsapp, hoy extendidas y utilizadas con normalidad por la práctica totalidad de nuestros jóvenes, apenas llegan al lustro desde su nacimiento<sup>1</sup>.

En la actualidad sigue vigente la expresión acuñada por Prensky (2001) para referirse a estas generaciones, nacidas a partir de mediados de los años 90, a las que denomina *nativos digitales*. Son generaciones que desde su nacimiento han crecido rodeadas de pantallas en entornos saturados de tecnología digital, hasta tal punto, que han *incorporado y naturalizado* estas herramientas como una extensión de sí mismos (Coll y Monereo, 2008). Ese proceso de apropiación de las TIC desemboca, como ya he comentado en el Capítulo 1, en una *mente virtual*, caracterizada por un apetito insaciable de información y estimulación constante, no exenta de riesgos.

Desarrollar una mente virtual estratégica (Adell, 1997; Monereo, 2004), adaptada a las exigencias de la Sociedad del Conocimiento, demanda un rol renovado por parte de los alumnos (Cabero y Barroso, 2015). Ya no basta con consumir saberes claramente definidos y bien acotados, pues la realidad bombardea constantemente con información nueva y fragmentada, donde las voces autorizadas se ponen en entredicho. En ese contexto, el alumno debe asumir progresivamente la responsabilidad y el control de su propio aprendizaje, ejerciendo un papel activo y comprometido. Al alumno del s. XXI ya no le sirve únicamente con guiarse con metas pragmáticas, útiles en un pasado donde el éxito se alcanzaba en la medida en la que uno era capaz de reproducir fielmente el contenido adquirido (Kirsh y Maglio, 1994; Pozo, 2008, 2014). En la Sociedad del Conocimiento, el alumno debe guiarse por metas epistémicas que le permitan dotar de sentido a los aprendizajes llevados a cabo, partiendo del dato para ir más allá del propio dato.

Como señalan numerosos autores (Cabero y Barroso, 2015; Coll y Monereo, 2008; Pozo, 2008, 2014), y como yo mismo he apuntado en el Capítulo 2, es éste precisamente un aspecto crítico en la formación de nuestros alumnos. El enfoque pragmático que caracteriza el uso de las TIC por parte de los nativos digitales, les convierte en individuos competentes desde el punto de vista técnico (es decir, son capaces de manejar con agilidad y soltura software diverso, acceder a múltiples fuentes de información, etc), pero con dificultades importantes para utilizarlas de forma estratégica (es decir, para diferenciar y juzgar la calidad de la información y las fuentes de las que procede, para distinguir intenciones expresivas y comunicativas, etc).

En la medida que los códigos empleados por las TIC no suponen una ruptura con el pasado, sino más una integración de sistemas externos de representación tradicionales (Martí, 2003), como el lenguaje escrito o los medios audiovisuales, muchos de los procedimientos y estrategias de esa mente letrada o teórica de la que hablé en el Capítulo 1 (Donald, 1993a), continúan en la actualidad siendo vigentes para el desarrollo de una competencia en el uso estratégico de las TIC.

Es por lo tanto esa, la alfabetización informacional de nuestros nativos digitales, una de las funciones más relevantes en la actualidad de la práctica docente. Pero para alcanzar ese

---

<sup>1</sup> Instagram fue lanzada el 6 de Octubre de 2010 (<https://en.wikipedia.org/wiki/Instagram>) y WhatsApp en Enero del mismo año (<https://en.wikipedia.org/wiki/WhatsApp>)

objetivo, no basta con repetir aquello que en el pasado fue útil. El rol y las funciones del profesorado también deben redefinirse para dar respuesta a las necesidades que demanda la Sociedad del Conocimiento.

### 3.2. El profesor en el s. XXI

Uno de los temores que persigue a la comunidad educativa con mayor frecuencia es la amenaza de que las TIC sustituyan al profesorado en su función docente (Collins y Halverson, 2009). Y hasta cierto punto, razón no les falta. La imagen del profesor como voz del conocimiento establecido, poseedor de la verdad objetiva e indiscutible que es transmitida fielmente a sus pupilos, se corresponde más bien con una época pretérita. En la actualidad, es tal la cantidad de información producida y la velocidad a la que cambia, que resulta una ingenuidad pretender que todo ese conocimiento descansa en una sola persona. Por este motivo, la respuesta a muchas de las preguntas que hoy en día se formulan los alumnos ya no se encuentra en el profesor, poseedor en el pasado de todo el conocimiento necesario, sino en la red, a través de ese conjunto de voces que se dan de forma colectiva (Pérez-Gómez, 2012).

Pero como todo conjunto de voces, para que suenen de forma armoniosa necesitan de un director de orquesta que sea capaz de hacerlas participar coordinadamente, puliendo cada detalle para encontrar el sonido perfecto. En la actualidad, es precisamente esa una de las funciones principales del profesorado: dotar a los alumnos de herramientas para permitir que las voces de internet suenen como un conjunto coral. Eso implica apropiarse de procedimientos y estrategias de búsqueda, selección y organización de la información, de evaluación y tratamiento de los datos, permitiendo posicionarse de forma crítica y argumentada en ese universo caótico (Pozo, 2008, 2014).

Frente al despliegue cada vez mayor de recursos disponibles en internet, donde con un simple “clic” podemos acceder a videos, tutoriales, webs temáticas y un sinfín de productos culturales de todo tipo, el profesor debe poner “conciencia” en todo ese proceso, lo que hace de este colectivo una pieza que continúa siendo clave en todo proceso formal de enseñanza y aprendizaje<sup>2</sup>. Por este motivo, el propio Monereo (2004) afirma, no sin cierta ironía, que aquél docente que pueda ser sustituido por las TIC (o por cualquier otro dispositivo mecánico y automatizado), ciertamente debe ser reemplazado por el bien del propio aprendizaje.

Según Pozo (2008), el profesor del s. XXI, si quiere hacer frente a las demandas de la Sociedad del Conocimiento, debe abandonar su papel como *proveedor* de saberes herméticos o como *modelo* de procedimientos rígidos e inflexibles<sup>3</sup>, y adoptar progresivamente una función menos intervencionista y directiva, a modo de *guía* o *tutor*, que cede responsable y paulatinamente al alumno el control de su propio proceso aprendizaje.

---

<sup>2</sup> En la inabarcable obra de John Hattie (2008), donde se sintetizan alrededor de 800 meta-análisis con el objetivo de determinar cuáles son los factores que influyen y mejoran el aprendizaje, una de las conclusiones obtenidas es que, tanto el profesor como los métodos pedagógicos y didácticos desplegados en el aula, son dos de los principales factores.

<sup>3</sup> Claxton (1990) denomina a este tipo de docente *gasolinero o escultor* y Olson y Bruner (1996) se refieren a ellos como *autoridad o artesanos*.

Pero para alcanzar este punto, de nuevo, no basta con repetir lo que tradicionalmente se venía haciendo. En una realidad social donde los saberes relevantes se renuevan con una velocidad vertiginosa, los contenidos de aprendizaje no pueden permanecer inalterables. En el siguiente apartado, reflexiono acerca de estos cambios y su repercusión sobre el *objeto* de aprendizaje.

### 3.3. El contenido de aprendizaje en el s. XXI

Puede que sea éste, de los tres elementos que componen el triángulo interactivo, el que menos transformaciones haya sufrido como consecuencia de los cambios producidos en la sociedad. Así lo reconocen Monereo y Pozo (2001) cuando afirman que *“a menudo la escuela enseña contenidos del siglo XIX, con profesores del s. XX a alumnos del s. XXI”* (p.50).

Como ya adelanté en el Capítulo 2, la escuela continúa respondiendo a una lógica, producto de la revolución industrial, donde se preparaba a los ciudadanos para desempeñar trabajos mecánicos y repetitivos. Dentro de este contexto, lo deseable era la homogeneidad y la uniformidad entre los individuos. Así, una escuela vertebrada a través de estos principios y con el objetivo de ofrecer una talla única para todos, favorecía la adquisición de contenidos rígidos y herméticos que representaban el cuerpo de conocimientos socialmente relevantes para la época.

Los tiempos han cambiado y sin embargo la escuela parece inalterable en muchos aspectos<sup>4</sup>. La herencia recibida es una escuela desbordada que transmite contenidos fragmentados y descontextualizados de los problemas e intereses de nuestros alumnos. Se trata de un modelo, según Wagner (2014), con un currículo de kilómetros de extensión, pero con tan sólo algunos milímetros de profundidad, donde se prioriza la cantidad de los contenidos sobre la calidad y el sentido de las experiencias. Como nos recuerda Robinson (2011), el sistema y modelo industrial podía ser mecanicista y lineal, pero la vida humana no, y en un contexto como el actual, donde la incertidumbre y el cambio es la normalidad, mucho menos (Pérez-Gómez, 2012).

En contraposición, los contenidos de aprendizaje de la escuela que quiere hacer frente a las demandas de la Sociedad del Conocimiento deben ser flexibles y transformables, útiles para esa sociedad líquida y poliédrica. Como ya mencioné anteriormente, eso significa que los contenidos no deben ser un fin en sí mismo, sino un medio para adquirir las competencias de las que hablé en el Capítulo 2, necesarias para desarrollarse y desenvolverse plenamente en la sociedad actual. Como señala Pérez-Gómez (2012), los contenidos deben favorecer la combinación personal entre conocimientos, emociones, actitudes y valores que orienten la actividad y toma de decisiones de los diferentes individuos.

Esos contenidos, puestos al servicio de las competencias, son la materia prima de esa mente epistémica (Kirsh y Maglio, 1994) o mente virtual estratégica (Adell, 1997; Monereo, 2004) que debemos desarrollar para hacer frente a las demandas sociales actuales. Para

---

<sup>4</sup> Como acertadamente sugiere Negroponte (1999), si un cirujano de mediados del s. XIX visitara cualquier quirófano actual, apenas podría reconocer nada. Sin embargo, si un maestro de la misma época visitara un aula corriente de nuestras escuelas, se sentiría familiarizado con casi todos los elementos (Monereo, 2004).



lograrlo, alumnos, profesor y contenidos deben operar conjuntamente de forma coherente y coordinada. Los *Artículos III y V* de esta tesis doctoral describen dos ejemplos concretos de este tipo de contexto.

A lo largo de este capítulo he tratado de describir las características y relaciones de los elementos que componen el triángulo interactivo con el objetivo de dar respuesta a las demandas de la Sociedad del Conocimiento. En el próximo capítulo me adentro en una de las líneas con mayor expansión en los últimos años dentro del campo de la integración de las TIC en contextos educativos, como es el uso de los videojuegos y *serious games* como herramientas de aprendizaje.

## Referencias

- Adell, J. (1997). Tendencias en educación en la sociedad de las tecnologías de la información. *Edutec. Revista electrónica de tecnología educativa*, 7.
- Cabero, J., y Barroso, J. (2015). Nuevos retos en tecnología educativa. Madrid: Editorial Síntesis.
- Claxton, G. (1990). *Teaching to learn: A direction for education*. Londres: Cassell.
- Coll, C., y Monereo, C. (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Collins, A. y Halverson, R. (2009). *Rethinking education in the age of technology. The digital evolution and schooling in America*. N. York: Teachers College Press
- Donald, M. (1993a). Precipitous Origins of the modern mind: Three stages in the evolution of culture and cognition. *Behavioral and brain sciences*, 16(04), 737-748.
- Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- Kirsh, D., y Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive science*, 18(4), 513-549.
- Martí, E. (2003). *Representar el mundo externamente. La construcción infantil de los sistemas externos de representación*. Madrid: Machado Libros
- Monereo, C. (2004). The virtual construction of the mind: the role of educational psychology. *Interactive educational multimedia: IEM*, (9), 32-47.
- Monereo, C. y Pozo, J. I. (2001). ¿En qué siglo vive la escuela? *Cuadernos de pedagogía*, (298), 50-55.
- Negroponte, N. (1999). Being digital in the wired world. *Masters of the wired world*, 386-394.
- Olson, D. R., y Bruner, J. S. (1996). Folk psychology and folk pedagogy. En D.R. Olson y N. Torrance (Eds.) *The handbook of education and human development, New models of learning, teaching and schooling*, 9-27. Cambridge: Blackwell
- Pérez-Gómez, M.A. (2012). *Educarse en la era digital*. Madrid: Morata
- Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon*, 9(5), 1-6.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J. I. (2014). *Psicología del Aprendizaje Humano: Adquisición de conocimiento y cambio personal*. Madrid: Morata
- Robinson, K. (2011). *Out of our minds: Learning to be creative*. John Wiley & Sons.
- Wagner, T. (2014). *The Global Achievement Gap: Updated edition*. Perseus Books Group.

## CAPÍTULO 5. VIDEOJUEGOS Y *SERIOUS GAMES*<sup>1</sup> COMO EJEMPLO DE INTEGRACIÓN EDUCATIVA DE LAS TIC

### Resumen

El presente capítulo justifica por qué los videojuegos se han convertido desde hace unos años en objeto de estudio como herramientas de aprendizaje en diversas áreas de conocimiento, prestando especial atención a las ciencias. Se plantean algunas cuestiones teóricas que en la actualidad son objeto de discusión en relación con los videojuegos y *serious games*, y por último se presentan diferentes modelos para el desarrollo de una mente epistémica a través del uso de esta tecnología.

Desde hace ya algunas décadas, y acentuado en los últimos años, los videojuegos se han situado en una posición privilegiada como objeto de análisis científico dentro de la investigación de las TIC como herramientas de aprendizaje (Clark, Tanner-Smith y Killingsworth, 2016; Garris, Ahlers y Driskell, 2002; Nawrocki y Winner, 1983; Randel, Morris, Wetzel y Whitehill, 1992). Numerosos han sido los trabajos llevados a cabo en áreas muy diversas (Bideau et al., 2010; Froschauer, Merkl, Arends y Goldfarb, 2013; Graafland, Schraagen y Schijven, 2012) con resultados igualmente dispares (Girard, Ecalle y Magnan, 2013; Sitzman, 2011). Por ejemplo, en un reciente meta-análisis llevado a cabo por Clark, Tanner-Smith y Killingsworth (2016) se afirma que el uso de videojuegos mejora significativamente el aprendizaje. Sin embargo, en una revisión dirigida por Young y sus colaboradores (2012) se encontró escasa evidencia empírica en áreas como las ciencias o las matemáticas. Algunos autores van más allá, como Girard, Ecalle y Magnan (2013), al afirmar que no se pueden extraer conclusiones fiables como consecuencia de las importantes limitaciones de los trabajos llevados a cabo hasta el momento. ¿Qué es lo que hace, a pesar de la disparidad de los resultados, mantener el interés de la comunidad científica por los videojuegos como instrumentos educativos?

### 5.1. Videojuegos y *serious games* como herramientas de aprendizaje: un breve recorrido por la historia

Los orígenes del videojuego se remontan a finales de la década de los años 50 del siglo pasado, con la aparición del rudimentario, a la par que famoso, *Tennis for two* (1958). A partir de un osciloscopio y un ordenador analógico se proyectaba en la pantalla una línea horizontal y otra vertical, simulando una pista de tenis y la red correspondiente. El juego consistía en calcular cómo golpear una supuesta pelota. Este sencillo mecanismo iniciaba el camino de una nueva forma de interactuar entre las máquinas y el ser humano (Lacasa, 2011).

Pronto surgirían nuevos títulos con funciones y diseños progresivamente más elaborados, como *SpaceWar* (1961), *Pong* (1972) o los aclamados *Space Invaders* (1978) y

<sup>1</sup> Como acertadamente señala Salvador Gómez (2014), la traducción literal “juegos serios” no recoge todos los matices incluidos en su forma original. Por este motivo, emplearé a lo largo del documento la expresión anglosajona *serious games*.

*Tetris* (1984). A partir de entonces la popularidad de los videojuegos se disparó, multiplicándose las diferentes sagas, como las innumerables versiones de *Mario Bros* (1983-2016) o de *Legend of Zelda* (1986-2016), de temática muy diversa<sup>2</sup>.

La industria del videojuego es un universo en expansión y evolución continua que conquista cada vez nuevas formas, y más sofisticadas, de interacción entre las máquinas y el ser humano. Ejemplo de ello son los más recientes proyectos de un mundo virtual como *Second Life* (2003), que sugiere una “verdadera” realidad alternativa para los usuarios o las posibilidades que ofrece el prometedor *Oculus Rift* (2016) y su propuesta de inmersión total en una realidad virtual.

Más allá de estas propuestas, que a menudo recuerdan a mundos de ciencia ficción<sup>3</sup>, la historia y evolución de los videojuegos se ha caracterizado por un crecimiento imparable que ha hecho de ellos uno de los productos culturales para el entretenimiento de mayor influencia (Squire, 2003; Tejeiro y Pelegrina, 2003). Según Squire (2003), su éxito reside en la enorme capacidad para provocar en los usuarios reacciones emocionales de gran intensidad. Estas reacciones se producen al combinar con eficacia diferentes componentes del juego, como son el equilibrio entre obstáculos y recompensas, competición y colaboración o el diseño de narrativas que permiten experimentar mundos posibles, sólo por mencionar unos pocos.

La enorme capacidad de los videojuegos para movilizar al usuario y generar experiencias completas de inmersión empujó a la comunidad científica a investigar sus posibilidades como herramientas educativas (Gee, 2003; Pivec y Pivec, 2009). En el ameno trabajo, aunque no por ello menos riguroso, titulado *What video games have to teach us about learning and literacy* (2003), Paul Gee analiza en profundidad los principios sobre el aprendizaje incorporados en los buenos videojuegos, ampliamente apoyados por los resultados de investigación en las ciencias cognitivas (Bruer, 1993; Clark, 1997; Lave, 1996). Mencionaré sólo algunos de los 36 principios identificados por este autor.

Según Gee, los buenos videojuegos ofrecen información contextualizada que rápidamente es puesta en práctica, algo en lo que a menudo fracasan las escuelas. En este sentido, los niveles iniciales funcionan frecuentemente a modo de “tutoriales ocultos” donde uno se va apropiando y desarrollando las habilidades necesarias para superar los niveles superiores. El videojuego bien diseñado se complejiza progresivamente a medida que el usuario aumenta su conocimiento y competencia, suponiendo en cada momento un reto exigente, pero superable, adaptado a la situación particular del jugador. Este ciclo de desarrollo de la pericia (Bereiter y Scardamalia, 1989) provoca una “placentera frustración” (Gee, 2003).

---

<sup>2</sup> Para una revisión en profundidad sobre la historia de los videojuegos ver la obra de Kent (2001) o la de Malliet y de Meyer (2005).

<sup>3</sup> Tanto en la cinematografía como en la literatura abundan las obras futuristas donde se especula sobre las posibilidades y consecuencias del uso masivo de estas tecnologías. Dos ejemplos interesantes son la novela de Stephen King titulada *“The Lawnmower man”* (1975), adaptada al cine en 1992, que describe cómo un individuo con discapacidad acaba adquiriendo poderes sobrenaturales como consecuencia de una práctica continuada en un programa de realidad virtual, y la película dirigida por Spike Jonze, *“Her”* (2013), cuya trama describe la relación amorosa entre un individuo corriente y un programa informático “corporeizado” únicamente en una voz femenina.

La posibilidad de desarrollar diversas identidades, así como asumir un papel activo, donde la acción del usuario revierte en el devenir del videojuego (a diferencia de lo que ocurre en el cine o con las novelas) o participar en comunidades donde es necesario colaborar y compartir conocimientos, habilidades y valores<sup>4</sup>, son otros de los principios que incluyen los videojuegos bien diseñados, relevantes desde el punto de vista del aprendizaje.

La incorporación de todos estos principios a videojuegos cuya motivación principal no es el entretenimiento, sino objetivos educativos, dio lugar a lo que hoy se conoce como *serious games* (Miller, Chang, Wang, Beier y Klisch, 2011). Aunque en la actualidad se trata de un término utilizado para referirse a esta clase de videojuegos, su origen se remonta a finales de los años sesenta del siglo pasado, cuando el terapeuta británico Clark Abt (1968) lo acuñó por primera vez (Gómez, 2014). Su ámbito de estudio contemplaba el análisis de los juegos tradicionales (juegos de mesa y cartas) como herramientas de aprendizaje de habilidades complejas necesarias para la sociedad.

El concepto de *serious games* no está exento de debate y discusión teórica. Aunque muchos autores coinciden en que se trata de “juegos de entretenimiento con objetivos que no lo son” (Prensky, 2001; Zyda, 2005), hay numerosos matices que son objeto de discrepancias. Por ejemplo, mientras que para Prensky (2001) o Zyda (2005) la diversión es condición imprescindible desde la que articular el aprendizaje, para David y Sande (2006) el objetivo educativo debe prevalecer sobre el entretenimiento. En una línea parecida, Marsh (2011) propone una definición de *serious games* como un continuo que va desde los juegos digitales con un propósito específico, hasta entornos digitales experimentales sin apenas características propias de los videojuegos, como pueda ser el entretenimiento<sup>5</sup>.

Otra dimensión polémica es la referida al diseño instruccional. Algunos autores como Conolly y sus colaboradores (2012) o Girard, Ecalle y Magnan (2013) consideran que, mientras que los videojuegos (como Super Mario Bros o Grand Theft Auto) son originalmente diseñados para el entretenimiento o la diversión, los *serious games* (como *Global Conflict: Palestine* o *PeaceMaker*) tienen por objetivo el aprendizaje de algún contenido o el cambio de comportamiento y actitudes. El propio Marsh (2011), sin embargo, considera que cualquier videojuego puede ser considerado *serious game* si es utilizado para el aprendizaje. Sawyer y Smith (2008) consideran que cualquier intento por conceptualizar y definir de forma precisa los *serious games* favorece la perspectiva y el área de interés de quién lo define, señalando así sus limitaciones como constructo teórico.

Videojuegos y *serious games*, independientemente de la precisión con que se definan, han sido utilizados en numerosas ocasiones para el aprendizaje en áreas tan diversas como la historia (Froschauer, Merkl, Arends y Goldfarb, 2013), el deporte (Bideau et al., 2010) o la medicina (Graafland, Schraagen y Schijven, 2012). Uno de los campos donde más se ha investigado es en el aprendizaje de las ciencias. En el siguiente apartado describo con mayor detenimiento esta realidad.

---

<sup>4</sup> Ver por ejemplo Wendel et al. (2013) para ver las posibilidades que ofrece en este sentido la plataforma Minecraft

<sup>5</sup> Marsh (2011) propone el juego *Fatworld* como ejemplo para concienciar sobre los hábitos alimenticios y *The Night Journey* como entorno experimental para la reflexión y la experiencia mística

## 5.2. ¿Por qué los videojuegos para el aprendizaje de las Ciencias?

El aprendizaje de la ciencia en general plantea numerosas dificultades. Si entrar a describir en profundidad las características idiosincráticas de las diferentes áreas, muchos de los conceptos que componen su corpus son de naturaleza compleja y abstracta (Cheng, Lin, She y Kuo, 2016). La elegante demostración elaborada por George Cantor en 1891 de que los números reales no son numerables, el fenómeno de la electrólisis por el cual la materia puede descomponerse a través de la electricidad, o la mecánica cuántica que afirma que la materia puede comportarse a la vez como partícula o como onda, son sólo alguno de los ejemplos.

La ciencia propone el aprendizaje de un conocimiento que a menudo entra en conflicto con nuestra experiencia cotidiana (Pozo y Gómez-Crespo, 1994, 2005). Así, como afirma Gómez-Crespo (2005), casi todos asumimos que *“un objeto no se moverá mientras no hagamos una fuerza sobre él y que se parará en cuanto se le “gaste” es fuerza”* (p.23), algo muy alejado de la representación que nos proporciona la física newtoniana, pero que se aproxima en mayor medida a la forma en la que percibimos el movimiento de los objetos. Como ya señalé en el Capítulo 3, los seres humanos nos desenvolvemos en el mundo guiados por concepciones y teorías implícitas que nos permiten representarnos la realidad que nos rodea y actuar en consecuencia. El conocimiento científico compite en muchas ocasiones con nuestro conocimiento cotidiano, profundamente *encarnado* en nuestras vivencias y experiencia diaria, muy útil en la mayoría de las situaciones que nos rodean.

Desde el *embodied cognition* se plantea la idea de que nuestras representaciones mentales emergen a partir de nuestra experiencia corporal y perceptiva cuando interactuamos con nuestro entorno (Han, 2013). A partir de estas experiencias, construimos modelos mentales que sirven como punto de partida para la comprensión de aspectos más formales (Black, 2010). Los videojuegos, más allá de todas las características descritas en el apartado anterior, pueden servir como escenario desde el que simular fenómenos complejos que nos permitan percibir ciertas dimensiones de la realidad que de otra forma serían difícilmente reproducibles (Anderson y Barnett, 2011). Y no solamente nos permiten simularlos, además nos dan la oportunidad de formular hipótesis y contrastarlas a través de estrategias iterativas sin necesidad de preocuparse por las consecuencias que pudiera tener en un contexto real (Spires, Rowe, Mott y Lester, 2011). Por ejemplo, Squire, Barnett, Grant y Higginbotham (2004) utilizaron el videojuego SuperChargued! para simular diferentes fenómenos electromagnéticos y permitir a los estudiantes que experimentaran con ellos. Los resultados mostraron que los alumnos que utilizaron el videojuego desarrollaron representaciones más elaboradas y resolvieron problemas más complejos que aquéllos que no lo utilizaron.

Sin embargo, como ya he señalado al comienzo del capítulo, la utilización de los videojuegos no siempre produce resultados positivos. Muy pocos son los que están suficientemente bien diseñados como para favorecer un aprendizaje significativo por el mero hecho de jugar con ellos (Tennyson y Jorczak, 2008). La ayuda pedagógica y el contexto instruccional es fundamental para conectar las posibilidades que ofrecen los videojuegos con los objetivos de aprendizaje planificados (Ke, 2009).

### 5.3. Uso de los videojuegos para el desarrollo de una mente epistémica

A lo largo del documento he señalado en varias ocasiones como los *nativos digitales* han incorporado y naturalizado las TIC, hasta convertirlas en una extensión de sí mismos. La habilidad con la que las utilizan de forma pragmática (basta con observar la velocidad con la que producen e intercambian mensajes de Whatsapp) contrasta con la dificultad que presentan a la hora de utilizarlas de forma epistémica (por ejemplo, para buscar información fiable y rigurosa).

El uso de los videojuegos responde a una lógica similar. En la mayoría de los casos los usuarios utilizan los videojuegos guiados por metas pragmáticas (con el objetivo de ir superando niveles), y no tanto desde posiciones epistémicas que les empujen a formularse cuestiones relacionadas con la comprensión del mundo que les rodea (Clark et al., 2011; Chang, Quintana y Krajcik, 2010). Este tipo de aproximación explicaría en gran parte por qué a menudo el aprendizaje a través de videojuegos se reduce a un nivel implícito en vez de explícito (Squire, Barnett, Grant & Higginbotham, 2004)

Clark et al. (2011) señalan que muchos de los videojuegos comerciales más populares, como *Portal*, *Tiguer Woods* o *Mario Galaxy*, están diseñados siguiendo principios newtonianos que, sin embargo, no parecen favorecer el aprendizaje de los aspectos más formales. Según los autores, el reto de este tipo de videojuegos<sup>6</sup> es ayudar al usuario a establecer conexiones entre los principios físicos implícitos y el desarrollo de conceptos y representaciones explícitas. Al igual que un jugador de golf no aprende la formulación matemática del movimiento parabólico de los objetos por el mero hecho de golpear la pelota, utilizar un videojuego comercial, cuyo objetivo original es el entretenimiento, tampoco lo garantiza.

Numerosos autores han propuesto diferentes modelos sobre cómo favorecer el aprendizaje mediado por videojuegos (Garris, Ahlers, y Driskell, 2002; Koops y Hoevenaar, 2012; Pivec y Pivec, 2009). Por ejemplo, Garris, Ahlers y Driskell (2002) describen la práctica como un proceso que comienza en un contexto virtual específico, con un diseño y unas reglas determinadas que son experimentadas por el jugador. El aprendizaje se produciría con la ayuda posterior ofrecida por el docente, a través de una reflexión sobre la acción dirigida a transformar el conocimiento implícito en explícito (Shaffer, 2006).

Por su parte, Pivec y Pivec (2009) y Koops y Hoevenaar (2012) proponen sendos modelos que serían una versión adaptada del ciclo de aprendizaje experiencial de Kolb (1984). Según este autor, y de forma congruente con las propuestas más recientes derivadas del *embodied cognition* (Black, 2010; Han, 2013), todo aprendizaje comienza en una experiencia concreta. A partir de ella, el aprendiz observa de forma reflexiva, focalizando su atención en un aspecto determinado de la experiencia. A menudo con la ayuda del docente (o de alguien más experto en el objeto en cuestión), se elabora una conceptualización formal a través de un

---

<sup>6</sup> A este tipo de videojuegos comerciales basados de forma bastante rigurosa en principios y leyes físicas, los autores los denominan "*conceptually-integrated games*", en contraposición con los simuladores virtuales 3D, a los que se refieren como "*conceptually embedded games*".

proceso de abstracción. Finalmente, se prueba la validez del conocimiento adquirido a través de una nueva experimentación activa. A continuación se describe el modelo general:

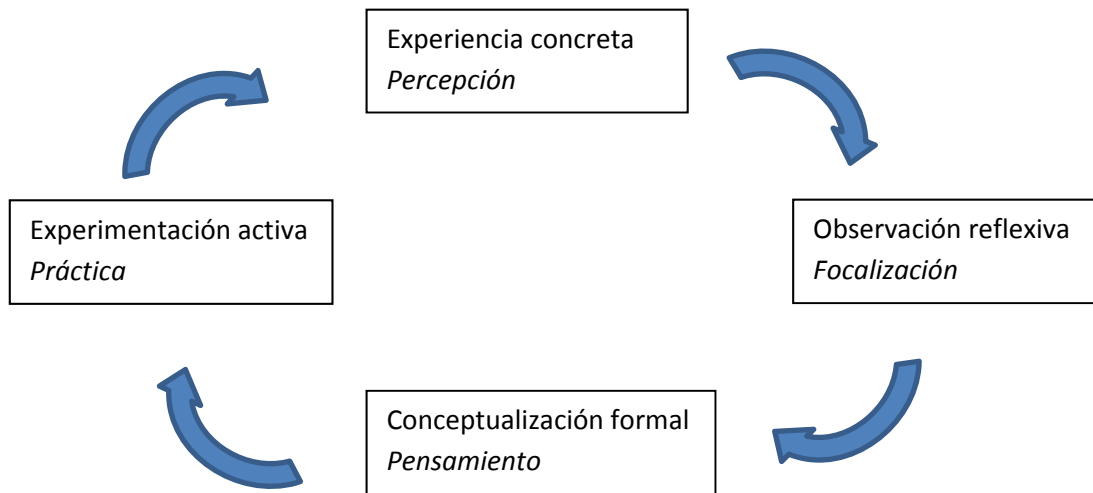


Fig.5.1. Ciclo de aprendizaje experiencial (adaptado de Kolb, 1984)

En el caso particular de la propuesta que ponemos en práctica en el *Estudio IV* sobre los diferentes usos del videojuego *Angry Birds*, el modelo varía ligeramente. En primer lugar, el estudiante experimenta el movimiento de los objetos a través del videojuego (experiencia concreta). A continuación se focaliza la atención en un aspecto determinado, por ejemplo en la relación entre el ángulo y la distancia alcanzada (observación reflexiva). En nuestro caso particular, la experimentación activa a través de la manipulación de los elementos del videojuego precede a la conceptualización formal. Independientemente del modelo, es fundamental que el docente, o un buen diseño del videojuego, ofrezca un andamiaje adecuado para conectar los aspectos implícitos con su correspondiente formulación conceptual (Clark et al., 2011).

## Referencias

- Abt, C. (1968). Games for Learning. En Boocock, S. y Schild, E. (Eds.) *Simulation: Games in Learning*. Beverly Hills, California: Sage Publications.
- Anderson, J., y Barnett, M. (2011). Using videogames to support pre-service elementary teachers learning of basic physics principles. *Journal of Science Education and Technology*, 20(4), 347-362.
- Bereiter, C., y Scardamalia, M. (1989). Intentional learning as a goal of instruction. *Knowing, learning, and instruction: Essays in honor of Robert Glaser*, 361-392.
- Bideau, B., Kulpa, R., Vignais, N., Brault, S., Multon, F., y Craig, C. (2010). Using virtual reality to analyze sports performance. *Computer Graphics and Applications, IEEE*, 30(2), 14-21.
- Black, J. B. (2010). An embodied/grounded cognition perspective on educational technology. In *New science of learning* (pp. 45-52). Springer New York.
- Bruer, J. T. (1993). *Schools for thought: A science of learning in the classroom*. MIT press.

- Chang, H. Y., Quintana, C., y Krajcik, J. S. (2010). The impact of designing and evaluating molecular animations on how well middle school students understand the particulate nature of matter. *Science Education*, 94(1), 73-94.
- Cheng, M. T., Lin, Y. W., She, H. C., y Kuo, P. C. (2016). Is immersion of any value? Whether, and to what extent, game immersion experience during serious gaming affects science learning. *British Journal of Educational Technology*.
- Clark, A. (1998). *Being there: Putting brain, body, and world together again*. MIT press.
- Clark, D. B., Nelson, B. C., Chang, H. Y., Martinez-Garza, M., Slack, K., y D'Angelo, C. M. (2011). Exploring Newtonian mechanics in a conceptually-integrated digital game: Comparison of learning and affective outcomes for students in Taiwan and the United States. *Computers & Education*, 57(3), 2178-2195.
- Clark, D.B., Tanner-Smith, E.E. y Killingsworth, S.S. (2016). Digital games, design, and learning: A systematic review and meta-analysis, *Review of Educational Research*, 86 (1), 79-122.
- Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., y Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2), 661-686.
- David, M., y Sande, C. (2006). *Serious Games: Games That Educate, Train, and Inform*. Course technology, Cengage learning.
- Froschauer, J., Merkl, D., Arends, M., y Goldfarb, D. (2013). Art history concepts at play with ThIATRO. *Journal on Computing and Cultural Heritage (JOCCH)*, 6(2), 7.
- Garris, R., Ahlers, R. y Driskell, J.E. (2002). Games, motivation and learning: A research and practice model, *Simulation & Gaming*, 33 (4), 441-467.
- Gee, JP (2003) What videogames have to teach us about learning and literacy. Palgrave Macmillan, New York.
- Girard, C., Ecalle, J., y Magnan, A. (2013). Serious games as new educational tools: how effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted Learning*, 29(3), 207-219.
- Gómez, S. (2014). *¿Pueden los videojuegos cambiar el mundo?: Una introducción a los serious games*. Universidad Internacional de La Rioja (UNIR Editorial).
- Gómez Crespo, M. Á. (2005). *Aprendizaje e instrucción en química. El cambio de las representaciones de los estudiantes sobre la materia*. Tesis Doctoral, Universidad Autónoma de Madrid.
- Graafland, M., Schraagen, J. M., y Schijven, M. P. (2012). Systematic review of serious games for medical education and surgical skills training. *British Journal of Surgery*, 99(10), 1322-1330
- Han, I. (2013). Embodiment: A New Perspective for Evaluating Physicality in Learning. *Journal of Educational Computing Research*, 49(1), 41-59.
- Jonze, S. (2013). *Her* [cinta cinematográfica]. Warner Bros Pictures.
- Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. *Handbook of research on effective electronic gaming in education*, 1, 1-32.
- Kent S.L. (2001). *The Ultimate History of Videogames*. New York: Three Rivers Press
- King, S. (1975). *The Lawnmower Man*. Cavalier.
- Kolb, D. (1984). *Experimental learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
- Koops, M., y Hoevenaar, M. (2012). Conceptual change during a serious game: using a



- lemniscate model to compare strategies in a physics game. *Simulation Gaming*, 44(1), 1-18.
- Lacasa, P. (2011). *Videojuegos. Aprender en mundos virtuales y reales*. Madrid: Ediciones Morata
- Lave, J. (1996). Teaching, as learning, in practice. *Mind, culture, and activity*, 3(3), 149-164.
- Leonard, B. (1992). *The Lawnmower Man*. [cinta cinematográfica]. New Line Cinema.
- Malliet, S. y de Meyer, G. (2005). The History of the Video Game. En J. Raessens y J. Goldstein (Eds.), *Handbook of Computer Game Studies* (pp. 23-45). Cambridge, MA: MIT.
- Marsh, T. (2011). Serious games continuum: Between games for purpose and experiential environments for purpose. *Entertainment Computing*, 2(2), 61-68.
- Miller L.M., Chang C.-I., Wang S., Beier M.E. y Klisch Y. (2011) Learning and motivational impacts of a multimedia science game. *Computers & Education* 57, 1425–1433.
- Nawrocki, L.H., y Winner, J.L.(1983). Videogames: Instructional potential and classification, *Journal of Computer-Based Instruction*, 10 (3/4), 80-82.
- Pivec, P., y Pivec, M. (2009). Immersed, but How? That Is the Question. *Human IT: Journal for Information Technology Studies as a Human Science*, 10(1).
- Pozo, J.I. y Gómez-Crespo, M.A. (1994). La solución de problemas en ciencias de la naturaleza. En Pozo, J.I. (Ed.), *La solución de problemas*. Madrid: Santillana
- Pozo, J.I. y Gómez-Crespo, M.A. (2005). The embodied nature of implicit theories: the consistency of ideas about the nature of matter, *Cognition and Instruction*, 23 (3), 351-387
- Prensky, M. (2001). *Digital game-based learning*. NewYork: McGraw Hill.
- Randel, J. M., Morris, B. A., Wetzel, C. D., y Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of recent research. *Simulation & Gaming: An Interdisciplinary Journal*, 23, 261-276.
- Sawyer, B., y Smith. (October 2008). *Keynote address. In The second European conference on games-based learning* (pp. 16–17). Barcelona Spain: Universitat Oberta de Catalunya.
- Shaffer, D. (2006). *How computer games help children learn*. New York: Palgrave MacMillan
- Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psychology*, 64(2), 489-528
- Spires, H. A., Rowe, J. P., Mott, B. W., y Lester, J. C. (2011). Problem solving and game-based learning: Effects of middle grade students' hypothesis testing strategies on learning outcomes. *Journal of Educational Computing Research*, 44(4), 453-472.
- Squire, K. (2003). Video games in education. *International Journal of Intelligent Games & Simulation*, 2(1), 49-62.
- Squire, K., Barnett, M., Grant, J. M., y Higginbotham, T. (2004, June). Electromagnetism supercharged!: Learning physics with digital simulation games. In *Proceedings of the 6th international conference on Learning sciences* (pp. 513-520). International Society of the Learning Sciences.
- Tejeiro, R., y Pelegrina, M. (2003). *Los videojuegos: qué son y cómo nos afectan*. Barcelona: Ariel.
- Tennyson, R. D., y Jorczak, R. L. (2008). A conceptual framework for the empirical study of instructional games. *Computer Games and Team and Individual Learning*, 3-20.
- Wendel, V., Gutjahr, M., Battenberg, P., Ness, R., Fahnenschreiber, S., Göbel, S., y Steinmetz, R. (2013, January). Designing a Collaborative Serious Game for Team Building Using

- Minecraft. In *European Conference on Games Based Learning* (p. 569). Academic Conferences International Limited.
- Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., ... y Yukhymenko, M. (2012). Our princess is in another castle a review of trends in serious gaming for education. *Review of Educational Research*, 82(1), 61-89.
- Zyda, M. (September, 2005). *From visual simulation to virtual reality games*. IEEE Computer.

## **SECCIÓN II**

---

# **OBJETIVOS GENERALES**

## Objetivos generales

Como ya adelanté al comienzo del documento en el apartado de *Resumen de la Tesis*, el **objetivo** general de este trabajo es *profundizar en el conocimiento sobre el proceso de integración efectiva de las TIC como herramientas de enseñanza y aprendizaje en contextos educativos*.

A lo largo de los diferentes capítulos introductorios he tratado de justificar la idea de que las TIC, a pesar de presentar características positivas desde el punto de vista educativo y de la adquisición del conocimiento, no son utilizadas de forma generalizada siguiendo criterios que aprovechen esas potencialidades.

Apoyándome en la idea ampliamente justificada de que las creencias epistemológicas y educativas influyen de manera decisiva en la forma en la que luego actuamos en contextos instruccionales (Golpnik y Melzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al. 2006), el primero de los **objetivos específicos** fue *profundizar en la relación que se establece entre las concepciones de los docentes y la forma en la que se apropian de las TIC como instrumentos educativos*. Para ello, en primer lugar se hizo un esfuerzo por actualizar y organizar conceptualmente el marco teórico de referencia, de cuyo trabajo se derivó el diseño de una herramienta de análisis y clasificación integradora y holística, denominado *FrameTEP* (ver *Estudio I-Artículo I*).

En una segunda aproximación al mismo fenómeno entendimos que la mirada debía ser más analítica, con el objetivo de profundizar en los detalles y matices de la relación entre concepciones y usos de las TIC. Por este motivo, se elaboró también otro instrumento de análisis, esta vez atendiendo a aspectos mucho más concretos, y se probó su funcionalidad con una muestra de profesores de primaria (ver *Estudio II- Artículo II*).

Si en la primera parte de la tesis nos centramos en el estudio de uno de los factores más relevantes a la hora implementar las TIC en contextos educativos, como son las creencias del profesorado, en la segunda parte nuestro **objetivo específico** fue el *análisis de la práctica*, compuesto a su vez por dos estudios. En el primero el objetivo fue *aportar evidencia empírica sobre las relaciones que se dan, en un entorno abierto y complejo mediado por las TIC, entre los elementos más relevantes en todo contexto formal de enseñanza y aprendizaje, es decir, profesor, alumnos y contenido*. Para ello, realizamos un estudio de caso donde observamos y analizamos de forma sistémica a un grupo universitario específico. El trabajo se llevó a cabo a lo largo de las diferentes sesiones de una unidad didáctica, que en todo momento estuvo mediada por un entorno digital de aprendizaje, donde los estudiantes fundamentalmente utilizaban las TIC para acceder, buscar y gestionar la información (ver *Estudio III-Artículo III*). La dificultad metodológica de este trabajo nos llevó a elaborar un manuscrito, a partir de esta investigación, donde ejemplificamos los principios básicos del *Análisis de Contenido* como metodología válida para la investigación educativa (ver *Estudio III-Artículo IV*).

El segundo estudio en relación con el *análisis de la práctica* tenía por objetivo *aportar evidencia empírica en cuanto a la relación existente entre diferentes usos o formas de implementar las TIC y resultados de aprendizaje*. Para ello, nos adentramos en una de las líneas emergentes con mayor expansión en los últimos años, como es la utilización de los videojuegos con objetivos educativos. Concretamente, llevamos a cabo un cuasi experimento en diferentes aulas de educación secundaria con el objetivo de evaluar en qué medida

## Objetivos generales

distintas formas de jugar al conocido videojuego *Angry Birds* permitía o no el aprendizaje de ciertos conceptos relacionados con el movimiento de objetos y el tiro parabólico (ver *Estudio IV-Artículo V*). La Tabla iv describe con más detalle los objetivos de cada trabajo.

**Tabla iv. Resumen de los Objetivos de la Tesis Doctoral**

OBJETIVO GENERAL	OBJETIVO ESPECÍFICO	ESTUDIOS EMPÍRICOS	PUBLICACIONES	TIPO DE TRABAJO	RESUMEN OBJETIVOS
PROCESO DE INTEGRACIÓN EFECTIVA DE LAS TIC EN CONTEXTOS EDUCATIVOS	RELACIÓN ENTRE CONCEPCIONES Y USOS DE LAS TIC	ESTUDIO I	<b>Artículo I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	Teórico/ Empírico	O1.1: Revisión constructos relevantes en relación con las creencias e integración de las TIC en contextos educativos: <ul style="list-style-type: none"> <li>✓ Creencias epistemológicas</li> <li>✓ Creencias pedagógicas</li> <li>✓ Enfoques pedagógicos</li> <li>✓ Competencia tecnológica</li> <li>✓ Niveles de aprendizaje</li> </ul> O1.2: Elaboración FrameTEP O1.3: Aplicación FrameTEP
		ESTUDIO II	<b>Artículo II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286, DOI: <a href="http://dx.doi.org/10.14204/ejrep.39.15062.pdf">http://dx.doi.org/10.14204/ejrep.39.15062.pdf</a>	Teórico/ Empírico	O2.1: Elaboración Sistema Categorical para el Análisis de las Creencias y Usos de las TIC O2.2: Identificar creencias profesorado O2.3: Identificar prácticas educativas mediadas por TIC O2.4: Identificar algunas variables relevantes relacionadas con las creencias y los usos de las TIC
	ANÁLISIS DE PRÁCTICAS MEDIADAS POR TIC	ESTUDIO III	<b>Artículo III</b> de Aldama, C. & Pozo, J.I. (in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective	Empírico	O3: Aportar evidencia empírica en cuanto a la relación de los elementos del triángulo interactivo en un entorno complejo de aprendizaje mediado por TIC: O3.1: Relación Contenido y Uso de las TIC O3.2: Relación Contenido-Alumno/s O3.3: Relación Contenido-Profesor O3.4: Relación Contenido-Estructura de

## Objetivos generales

					participación
			<b>Artículo IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd	Metodológico	O4: Describir principios básicos del <i>Análisis de Contenido</i> como método de investigación en Educación: O4.1: Relación enfoque teórico-preguntas de investigación-análisis de contenido O4.2: Procedimiento para el desarrollo de categorías de análisis: <i>feed-back looping process</i> O4.3: Elaboración de reglas de codificación específicas
		ESTUDIO IV	<b>Artículo V</b> de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool	Empírico	O5.1: Aportar evidencia empírica en cuanto al aprendizaje de conceptos sobre el movimiento de objetos, fruto del uso pragmático y epistémico del Angry Birds O5.2: Efecto del uso del Angry Birds sobre “creencias ingenuas” en relación con el movimiento de objetos (p.ej: “speed-mass belief”) O5.3: Efecto sobre el aprendizaje del uso individual o por parejas del Angry Birds



# **SECTION II**

---

# **GENERAL AIMS**

As I have mentioned in the *Abstract* of the doctoral dissertation, the general **aim** of the thesis is *provide knowledge about the process of ICT integration as teaching and learning tools in educational contexts*.

Through the different introductory chapters I've tried to justify that, although ICT present positive features from a learning point of view, they are not generally used taking account their possibilities.

Based on the shared idea that epistemological and educational beliefs have large impact on the way that we behave in instructional contexts (Golpnik & Melzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al., 2006), the first **specific aim** was to *augment the knowledge about the relationship between teachers' beliefs and how they use ICT as learning tools*. Regarding this, in collaboration with Dr. Sarah Prestridge, we firstly updated and reorganized conceptually the reference framework, reviewing the most important constructs like epistemological and educational beliefs, pedagogical approaches, levels of learning or technology competency. We finally designed a holistic tool for analysis and classification of teachers' beliefs and uses of ICT, called *FrameTEP* (see *Study I-Manuscript I*).

In a second approach of the same phenomena we used a more analytical view, paying attention to details related with Results, Process and Conditions of learning (Pozo & Postigo, 2000). We also developed another tool for analysis and classification of teachers' beliefs and uses of ICT (see *Study II- Manuscript II*).

So far, this is the first part of the thesis. Based on the idea that effective integration of ICT in educational contexts is not just a matter of beliefs, we decided to move on towards the second specific **aim**, the *analysis of relevant practices mediated by ICT*. In *Study III* the aim was to provide empirical evidence about the relationship between the three main components in any teaching and learning context (teacher, students and learning content known as "*interactive triangle*") when their actions were mediated by ICT. In this regard, we conducted a case study where we observed and analysed the interactions between those elements in a specific context. In this case ICT were used to access, search and manage information (see *Study III-Manuscript III*). The methodological complexity of this work resulted in the elaboration of *Manuscript IV*, where we exemplified the basic principles of *Content Analysis* as research method in education.

In *Study IV* we analysed another practice mediated by ICT. In this case, we explored one of the most popular research lines in recent years related with integration of ICT in educational contexts, such as the use of videogames as learning tools. Basically, we conducted a quasi-experiment where we assessed how different uses of the well-known videogame *Angry Birds* involved different learnings about conceptual knowledge related with projectile motion (see *Study IV-Manuscript V*). Table v describes a summary with the aims of each study:

**Table v.** Summary of the Doctoral Dissertation's aims

GENERAL AIM	SPECIFIC AIMS	EMPIRICAL STUDIES	PUBLICATIONS	TYPE OF WORK	SUMMARY OF AIMS
EFFECTIVE INTEGRATION PROCESS OF ICT IN EDUCATIONAL CONTEXTS	RELATIONSHIP BETWEEN CONCEPTIONS AND USES OF ICT	STUDY I	<b>Manuscript I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	Theoretical/ Empirical	A1.1: Review of relevant constructs related with beliefs and integration of ICT in educational contexts: <ul style="list-style-type: none"> <li>✓ Epistemological beliefs</li> <li>✓ Pedagogical beliefs</li> <li>✓ Pedagogical approaches</li> <li>✓ Technology competency</li> <li>✓ Levels of learning</li> </ul> A1.2: Elaboration of <i>FrameTEP</i> A.3: Application of <i>FrameTEP</i>
		STUDY II	<b>Manuscript II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286, DOI: <a href="http://dx.doi.org/10.14204/ejrep.39.15062.pdf">http://dx.doi.org/10.14204/ejrep.39.15062.pdf</a>	Theoretical/ Empirical	A2.1: Elaboration of Categorical System for Analysis of Beliefs and Uses of ICT A2.2: Identify teachers' beliefs A2.3: Identify teachers' practices mediated by ICT A2.4: Identify some key variables related with beliefs and uses of ICT
	ANALYSIS OF RELEVANT PRACTICES MEDIATED BY ICT	STUDY III	<b>Manuscript III</b> de Aldama, C. & Pozo, J.I.(in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective	Empirical	A3: Provide empirical evidence about the relationship between <i>interactive triangle</i> when their actions are mediated by ICT A.3.1: Relationship Learning Content-Uses of ICT A.3.2: Relationship Learning Content-Student/s A.3.3: Relationship Learning Content-Teacher A.3.4: Relationship Learning Content- Structure of Participation

## General aims

			<b>Manuscript IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd	Methodological	A4: Describe basic principles of <i>Content Analysis</i> as research method in education A4.1: Relationship between theoretical approach-research questions-content analysis A4.2: Procedure to develop categories of analysis: <i>feedback-looping process</i> A4.3: Elaboration of specific rules of codification
		STUDY IV	<b>Manuscript V</b> de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool	Empirical	A5.1: Provide empirical evidence about pragmatic and epistemic use of Angry Birds and results of learning A5.2: Effect of Angry Bird use over naïve conceptions related with object motion (e.g. " <i>speed-mass belief</i> ") A5.3: Effect of individual or per pairs use of Angry Birds over learning results

## **SECCIÓN III**

---

# **ESTUDIOS EMPÍRICOS**

**CAPÍTULO 6: CONCEPCIONES DEL PROFESORADO E INTEGRACIÓN DE LAS TIC EN CONTEXTOS EDUCATIVOS (ESTUDIOS I Y II)**

---

## ***Estudio I-Artículo I***

---

Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice-FrameTEP, Journal of Educational Computing Research, 1-21, DOI: 10.1177/0735633116636767

### **Abstract**

This article theorizes the construction of a classification framework to explore teachers' beliefs and pedagogical practices for the use of digital technologies in the classroom. There are currently many individual schemas and models that represent both developmental and divergent concepts associated with technology-enabled practice. This article draws from a depth of literature in this field to synthesize a classification framework used as an analytic tool to interpret technology-enabled practice. The framework was drawn from literature covering teachers' epistemic beliefs, pedagogical beliefs, pedagogical approaches, technological competency, and perceived levels of learning. It emerged as a result of the need to analysis case study data from a large-scale research project into the effective use of digital games in the classroom: *Serious Play: Digital Games, Learning and Literacy for Twenty First Century Schooling*. Yin suggests the use of a uniform framework to enable cross-case synthesis. The framework provides an analytical tool to help interpret why and how teachers are using, in this case, digital games in their classrooms. It also provides a significant contribution to the variances in technology-enabled practice along the traditional-constructivist continuum as well as to the relationship in how teacher beliefs direct pedagogical practice and choice of technologies used for learning.

### **Background**

Picture this: I am invited into a Year 2 classroom where the class of 28 boys and girls are sitting on floor at the back of the room, legs crossed, eyes ahead watching a small TV monitor. The teacher, Judy, welcomes me then resumes her position beside the TV. I sit at the back to absorb the scene. Much excitement and controlled giggles are let out, Charlotte calls out "go left, over near the picture on the wall," "No, no," calls Mick, "it's under the table. I can see it sticking out." I'm still trying to work out what is happening until I realize there is a control in the hands of a child sitting in the front row near the TV. He is moving the character around on the TV screen. The class is playing a Play Station game called *Ratchet and Clank*. "Stop there, Tom" says Judy while pointing to the TV screen. "What do you think that is, sticking out from under the Table? Have we seen that thing before?" "Oooh that's ugly" laughed Sally, "It's got a big head" another calls. Judy quiets the children down. "Tell me some adjectives to describe this character?" asked Judy. The children begin to call out descriptive words, which she writes down on the board beside her. Play resumes with the control in Tom's hands and the children giving him directions. Every so often Judy stops play and discusses an object or action, relates the play back to previous playtime or discusses a point in the game. After 10 minutes of play, another child is given the control and the game resumes. This continues for 40 minutes.

This descriptive recount depicts one of the teachers that I visited routinely as part of the *Serious Play* research project. My task as the researcher associated with this teacher's school was to plan and collect data on the way she was using digital games in her classroom. Data collected included student surveys, photo-graphs, student work, planning documentation, and teacher semistructured interviews twice yearly for 3 years. As a qualitative researcher, I was interested in understanding why Judy chose the *Ratchet and*



Clank Play Station Game, what beliefs underpinned her choice of the digital game, and how she implemented it in the classroom. I needed a framework, a schema, and a compilation of current understandings in the field of information and communication technology (ICT) pedagogies to help me interpret what I was observing.

In seeking direction for this, researchers have investigated the broader link between pedagogy and technology and specific concepts. Looi, Sun, Seow, and Chia (2014) described the relationship between pedagogy and technology in terms of teachers' appropriation of technology, identifying that teachers' pedagogical orientations, their teaching practices, and the intended curriculum direct their use of technologies in the classroom. Similarly, Koehler and Mishra's (2009) Technological Pedagogical Content Knowledge acknowledged the interplay of the content to be taught, how it is taught, and how technology changes content, pedagogy, and integration. Alternatively, Loveless (2011) identified four different ways technologies can be used in learning, which must appropriate pedagogies differently. These include as tutor, tool, resource, and environment. More specifically, types of pedagogical practices, epistemic and pedagogical beliefs, teacher competencies, and student learning outcomes from technology integration are some of the more focused topics researchers have identified. What is missing from the research literature is a synthesis of these specific concepts and the relationships they have with one another, drawn into a useable framework. This framework, it is hoped, would provide researchers with a lens for describing critical relationships within game-based pedagogy and for more general technology-enabled practices.

As the purpose of this article is to synthesize the literature into a useable framework to help in the process of interpreting raw data, it is conceptually driven rather than research based. As such, the main purpose of this article is to build the framework. However, to demonstrate the framework's usability as an illustration of its transferability and dependability, the framework will analyze data drawn from the research project that was the antecedent for its construction—Serious Play: Digital Games, Learning and Literacy for Twenty First Century Schooling, funded by the Australian Research Council (2012–2015). The Serious Play project investigated what happens to literacy and learning, curriculum, pedagogy, and assessment when digital games were introduced into schools. The study involved partners across two Australian states—Queensland and Victoria—and brought together a large research team with teachers in five primary schools and five secondary schools. In each school, a member of the research team worked closely with the teachers and students. Each teacher was considered a single case with data collected through planning sessions, twice yearly interviews, classroom observations, teacher blog posts, and curriculum documentation. This article will use a short descriptive segment from three teacher's single cases to apply the framework.

## Building a Classification Framework for Technology-Enabled Practice

Literature in the areas of teacher epistemic beliefs as well as teacher pedagogical beliefs, teacher pedagogies practices, student learning outcomes, and teacher competencies were reviewed and synthesized into one framework that best represents this literature.

### *Teacher epistemic beliefs*

Perry's (1970) seminal work on epistemic beliefs provided a developmental trajectory of four stages that includes (a) dualistic view is where individuals believe in right-or-wrong knowledge handed down by authority, (b) multiplistic stage is where they begin to acknowledge the possibilities of multiple views but still believe that most knowledge is certain, (c) relativistic view is where they see most knowledge as tentative and contextual and generated by the self, and (d) commitment with relativism is where they commit to themselves that knowledge is uncertain and based on the weight of accumulated evidence. Focusing on women's epistemological development, Belenky, Clinchy, Goldberger, and Tarule (1986) provided a schema similar to Perry: (a) silenced or receiving knowing, (b) subjective knowing, (c) procedural knowing, and (d) constructed knowing. Both of these schemes are considered developmental.

Alternatively, Schommer (1990) advocated a multidimensional model that conceives epistemic beliefs as a system of independent beliefs. The first two dimensions focus on beliefs about learning: innate ability and quick learning while the second two dimensions focus on beliefs about knowledge: simple and certain knowledge. Another dimension was added in later developments by Schommer and associates (Schommer & Walker, 1995; Schraw, Bendixen, & Dunkle, 2002) as Omniscient Authority which means an acknowledgment that the authorities have access to other inaccessible knowledge. Hammer and Elby (2002) conceptualized epistemic beliefs as made up of both naïve and sophisticated resources that individuals draw on in different contexts.

Table 6.1.1 presents a culmination of these categories. In building a classification framework (see Table 6.1.5) for teachers' technology-enabled practices, Perry's (1970) seminal work provided four types of epistemic beliefs that have been foundational in this field. As this is a developmental continuum, it represents learning and knowledge processes that are naïve, sophisticated, and relative. Rokeach (1968) talks about the strength or stability of a belief by its positioning in the belief system: The more central a belief is within what he calls the "central-peripheral dimension" (p. 13) as well as the more connections it has with other beliefs indicates the less this belief is likely to change. This idea suggests that beliefs are established during earlier experiences and become stronger over time as they are used to process subsequent experiences (Pajares, 1992). Nespor (1987) suggested beliefs gain their strength from their "unboundedness," which means that the connection a belief has with another is highly variable, unpredictable, unstable, and uncertain, indicating that there is no clear logical rule for the connection. On top of this illogical formation, the linkages are bounded with emotional and personal experiences. This premise suggests that teachers' beliefs vary in strength and kind, and the ease with which teachers change their beliefs is related to the strength of the belief under challenge. This is fundamental to our understanding of how and why teachers change their practice with the use of technologies in the classroom.

To gain insight into teachers' use of games in their classroom, a greater understanding of what informs teacher practice is required. Pajares (1992) suggested that teachers' epistemic beliefs affect their teaching practice and that the relationship between epistemic beliefs and teaching practices is mediated by teachers' pedagogical beliefs (Hofer, 2001). The schemas that represent teacher's pedagogical beliefs are now presented.

**Table 6.1.1.** *Summary of teacher Epistemic Beliefs*

Perry (1970)	Dualistic	Multiplistic	Relativistic	Relativim
Belenky et al. (1986)	Silenced or receiving knowing	Subjetive knowing	Procedural knowing	Constructed knowing
Schommer (1990)	Learning: innate-quick/ Knowledge: simple-certain-omniscient			
Hammer and Elby (2002)	Naïve and sophisticated resources			

#### *Teacher's Pedagogical Beliefs About ICT*

Pedagogical beliefs are understandings, premises, or propositions about education (Tondeur, van Braak, & Valcke, 2007) preferred ways of teaching by teachers (Chai, 2010) formed over many years of experiences, from life as a pupil in the classroom (Keys, 2007; Richardson, 2003) to the variety of professional context teachers encounter (Prestridge, 2012). These can be conceived as goals, purposes, and reasons for the use of technologies in education.

Tondeur et al. (2007) found three types of goal orientations for the use of technology in educational contexts: basic computer skills (technological competency), computer as an information tool (to research and process information), and computer as learning tool (to practice knowledge and skills). These three categories of teacher's pedagogical beliefs can also be seen within Downes et al. (2001) report on teachers' goals for the integration of ICT as Goal A—Development of skills—aligns with Tondeur's basic computer skills, whereas Goal B—ICT as a learning tool—includes both information and learning tool. However, Downes' Goal C—ICT as changing content and pedagogy—identifies beliefs that intend to transform existing curriculum practices.

Ertmer's (1999, 2005; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur et al., 2012) research has been focused on understanding the relation-ship between beliefs and practices for technology integration. Her three categories of pedagogical beliefs align well with Downes but do not include a skill development category: (a) Supplements the required curriculum where teachers believe that technology was to motivate, reinforce, and practice subject skills such as math facts; (b) Enrich the existing curriculum where teachers believe that technology was an educational tool for teaching content, collaboration, and higher order

thinking; and (c) Facilitates an emerging curriculum where teachers' believe that technology is a transparent tool for 21st-century literacies that transform the way students' learn. Prestridge (2012) identified four types of beliefs that underpin pedagogical approaches to technology use.

**Table 6.1.2.** *Summary of Pedagogical Beliefs About ICT*

Tondeur et al. (2007)	Basic computer skills	Computer as an information tool	Computer as learning tool		
Downes et al. (2001)	Development of skills	ICT as a learning tool		Changing content and pedagogy	
Ertmer (1999; 2005) and Ertmer et al. (2012)	Supplement the required curriculum	Enrich the existing curriculum		Facilitates an emerging curriculum	
Prestridge (2012)	Skill-based	Functional	Developing	Digital	
Mama and Hennessy (2013)	Convenient		Powerful	Diversifyng	Subversive

*Note.* ICT = Information and communication technology

Similarly, there is the skill-based category, the functional (as in productivity outcomes such as wordprocessing) and developing category where teachers orient their beliefs to augment and enrich the existing curriculum, and a digital category where teacher beliefs emphasized exploring new ways of learning and opportunities with ICT in digital spaces. Mama and Hennessy's (2013) four categories of Diversifying—enabling different approaches to learning, Powerful—as an exciting learning tool, and Convenient—administrative functions and practice of subject skills, which also align to existing categories. These authors add one further type, Subversive—identifying teacher's fear of being replaced and therefore avoiding its use in classrooms. Table 6.1.2 shows an alignment of these ideas in this area.

There is a strong alignment in categories associated with pedagogical beliefs. There are four categories that encompass pedagogical beliefs; these include teacher's beliefs about developing (a) computer skills or competencies in the technology itself, (b) supplementing the curriculum, (c) enriching existing curriculum, and (d) facilitating new ways of learning. Categories of computer skilling and supplementing the curriculum, that is, reinforcement/practice of content, are both considered functional practices. As such, these were grouped together in the framework and aligned to the other classification categories (see Table 5).

### *Teacher Pedagogical Practices With ICT*

Teacher pedagogical practice has been a topic extensively studied from many different approaches (Budge & Cowlshaw, 2012; Kember & Gow, 1994; Meyer & Eley, 2006). Generally, and in line with pedagogical beliefs, teachers' pedagogical practices can be categorized as having a constructivist orientation and a traditionalist or objectivist orientation (Becker & Riel, 2000; Hadley & Sheingold, 1993). Constructivist pedagogical practices can be described as the implementation of activities that enable students to actively participate in discussion, collaboration, inquiry, and reflection to support the development of more accurate and reasoned knowledge. Whereas traditionalist pedagogical practices direct students to learn through a series of steps that lead to the production of intended and targeted knowledge.

There are many models that are used to categorize pedagogical practices with ICT. Kemmis, Atkin, and Wright (1977) provided teaching models as Instructional—divides the learning activities into smaller units with use of positive or negative feedback for corrections, Revelatory—presenting a series of activities or knowledge in order for students to discover the concept, and Conjectural—enables students to manipulate ideas and hypotheses to develop knowledge. In Table 6.1.3, these categories align within the traditional-constructivist continuum. Trigwell and Prosser (1996) and Ertmer et al. (2012) helped explain the space between traditional pedagogy and constructivist pedagogy labeling on a scale of Teacher-centered (TC) and Student-centered (SC) with a Mix for TC, SC, or balanced (see Table 3). This helps explain the variances in pedagogical approaches with ICT along the continuum.

From a cognitivist psychology perspective, López-Íñiguez and Pozo (2013) proposed a model about teachers' conceptions of teaching and learning through three dimensions: (a) direct conception, (b) interpretative conception, and (c) constructivist conception. In direct conception, as with Instructional or traditional practices, there is a clear connection between teaching approaches and desired learning outcomes. Knowledge is considered certain and the teacher must transmit to the learner in exact terms. The communication between teacher and learner is in a one-way direction. Interpretative conception takes into account the existence of complex, dynamic mental processes in the learner, although it considers that control of learning should still be in the hands of the teacher. The knowledge must also be taught as exactly as possible, but in this case, consideration is given to differentiation of learners' needs. This equates more to Ertmer's Mix-Primarily TC approach. Constructivist conceptions mirror previous explanations.

Specifically associated to ICT integration, Donnelly, McGarr, and O'Reilly (2011) added a multidimensional approach where teachers are classified based on two dimensions: Assessment or Learning focused and Empowerment or Helplessness dimension. There are four possible categories for teacher practice: Contented traditionalist—teach toward assessment and adopt ICT using traditional practices, Selective adopter—use ICT in traditional ways that enable better outcomes for assessment of existing curriculum, Creative adapter—have a strong focus on student-centered approaches that facilitate meaningful learning, and Inadvertent user—are more oriented to using ICT in a student-centered fashion if it is perceived as a school requirement. This final category aligns to Ertmer's Mix-Primarily SC approach.

**Table 6.1.3.** *Summary of Pedagogical Practices with ICT*

Chan and Elliot (2004)	Traditional conception				Constructivist conception
Kemmis et al. (1977)	Instructional		Revelatory		Conjectual
Ertmer et al. (2012)	Teacher-centered (TC)	Mix-primarily (TC)	Mix-balanced	Mix-primarily (SC)	Student-centered (SC)
López-Íñiguez and Pozo (2013)	Direct		Interpretative		Constructivist
Donnelly et al. (2011)	Contented traditionalist	Selective adopter		Inadvertent user	Creative adapter

Like pedagogical beliefs, there is a strong alignment with categories for pedagogical practices. Culmination of these categories in Table 6.1.3 shows five types of pedagogical practices drawing mainly from Ertmer's work: (a) Teacher Centre, (b) Primarily Teacher Centered, (c) Mix-balanced, (d) Primarily Student Centered, and (e) Student Centered, as it is representational of the other categories and expands on variances between traditional pedagogy and constructivist pedagogy. The final body of literature to explore is focused on student outcomes or levels of learning.

#### *Levels of Learning With ICT*

What teachers perceive as the learning outcome or the complexity of a given task is critical in the choice of the digital tool or resource they use to enable subject knowledge to be taught. With regard to the use of digital games, teachers' perceptions of the level of learning that students engage with is both a predictor for how and why they use games in the classroom. Therefore, it is important to provide a framework for the types of learning that exist when students interact with digital games. MacDonald et al.'s (1977) seminal work presented five categories on the cognition required in a learning task: (a) Recognition—to recognize information, (b) Recall—correctly remember information, (c) Reconstructive understanding—to reproduce information taking into account its meaning, (d) Intuitive understanding—to use information and reconstruct its semantic structure, and (e) Constructive understanding—students can propose a new problem within the knowledge domain. These five categories are evident in Biggs and Collis (1982), Anderson and Krathwohl (2001), and Pozo and Postigo's (2000) taxonomies that move from surface to deep learning.

**Table 6.1.4.** *Summary of Levels of Learning with Technologies*

MacDonald, Atkin, Jenkins & Kemmis (1977)	Recognition	Recall	Reconstructive understanding	Intuitive understanding	Constructive understanding	
Biggs & Collis (1982)	Pre structural	Uni structural	Multi structural	Relational level	Extended abstract	
Anderson & Krathwohl (2001)	Remember	Understand	Apply	Analyze	Evaluate	Create
Pozo & Postigo (2000)	Acquisition	Interpretation	Analysis	Understanding and organization	Communication or reconstruct	
Starkey (2011)	Doing	Thinking about connections	Thinking about concepts	Critiquing and evaluating	Creating knowledge	Sharing knowledge

Starkey (2011) devised a digital learning matrix that identifies six ways in which children learn when using technologies. Based on Anderson and Krathwohl's modification of Blooms Taxonomy, the six levels include (a) Doing—such as looking up information on the Internet or using a quiz for factual recall; (b) Thinking about connections—compare and share activities or connecting to a person to share ideas; (c) Thinking about concepts—engaging with big ideas; (d) Critiquing and Evaluating—exploring the limitations and potential of information; (e) Creating knowledge—developing an original product; and (f) Sharing knowledge—brings together the ideas of connectedness, critique, and creativity where knowledge is shared through a feedback cycle.

As shown in Table 6.1.4, the categories that describe levels of learning in a useful progression focused on knowledge within the learner and what the teacher would perceive as the knowledge requirements for a given task. When technologies are introduced into the task however, Starkey (2011) acknowledged the learning or knowledge that occurs between the learners in a connected world. This is useful when thinking about the use of digital games in the classroom as playing, making, and analyzing digital games that can be accessible for single or multiple users across time and space, reflecting cognitive requirements beyond individual learner engagement.

#### *A Classification Framework for Technology-Enabled Practice*

Drawing on the literature presented here, a classification framework for teachers' use of technologies has been constructed. Teachers' epistemic beliefs, teacher pedagogical beliefs, teacher pedagogies practices, levels of learning, and technological competencies have been combined into a working classification framework. Each domain has been chosen as a representative of the combined literature in that area as summarized in each section earlier. The alignment of the subcategories has been made based on the presentation of ideas in the literature. Technological competency, which is the level of personal skill a teacher has with various hardware and software, has been rated on a standard scale and included in the framework. This classification framework provides one representation only (acknowledging

many variances across the categories) and will be used as a lens to examine the ways teachers are currently using digital games in their classrooms. It has been called FrameTEP (Table 6.1.5).

**Table 6.1.5.** *Classification Framework for Technology- Enabled Practice (FrameTEP)*

Epistemic beliefs	Dualistic view	Multiplistic	Relativistic	Relativism	
Pedagogical beliefs	Developing computer skills and supplementing subject skills	Enrich existing curriculum		Facilitating new ways of learning	
Pedagogical practices	Teacher-centered	Primarily teacher-centered	Mix-balanced	Primarily student-centered	Student-centered
Levels of learning	Doing	Thinking about connections	Thinking about concepts	Critiquing and evaluating	Creating knowledge
Technology competency	Low	Medium		High	

#### *Application of FrameTEP*

##### **Case Study 1: Lucy**

Lucy sat the children in her Year 1 classroom down on the floor in front of a whiteboard as she sat to the side next to a computer. She projected the reading tutorial called Reading Quest on the whiteboard. Lucy demonstrated to the children how to log on, the buttons to press to answer a quiz, and how to proceed to the next level. There were specific instructions that she gave the students to ensure that they understood how the computer game worked. Next she chose a child from the class. He played a few of the quizzes. Following this, the children were split into groups for rotational activities. One group went to the bank of computers on the side of the classroom. Each child logged on and started playing Reading Quest. They used headphones and the teacher monitored this group.

Lucy evidences teacher-centered pedagogy as she demonstrated the game in front of the classroom, the step by step procedure of the game for engagement was important, and emphasized that she was in total control of game play. Her dualistic views are evident based on the fact that she chose a reading tutor where knowledge is represented as right or wrong and sequenced in complexity. Her pedagogical beliefs indicate that she identifies the use of digital games as a tool to support specific curriculum skills, in this case reading skills, through rote learning exercises. The students primarily are “doing” or completing a given task issued by the digital game. Practicing reading skills is considered the valuable outcome. Lucy expressed that she was new to using computer games and has little familiarity and competency (Table 6.1.6).



Table 6.1.6. Classification Framework of Lucy's Use of Reading Quest.

Epistemic beliefs	<b>Dualistic view</b>	<u>Multiplicitic</u>	Relativistic		Relativism	
Pedagogical beliefs	<b>Developing computer skills &amp; supplementing subject skills</b>	Enrich existing curriculum			Facilitating new ways of learning	
Pedagogical practices with ICT	<b>Teacher Centred</b>	Primarily Teacher Centred	Mix-balanced	Primarily Student Centred	Student Centred	
Levels of learning	<b>Doing</b>	Thinking about connections	Thinking about concepts	Critiquing and evaluating	Creating knowledge	Sharing knowledge
Technological competency	<b>Low</b>	Medium			High	

### Case Study 2: Judy

Judy used the adventure game Ratchet and Clank on a Play Station as an interactive “Big Book” for language activities with her Year 2 class. The class sat around a TV and took turns passing the control. There was lots of verbal directions and encouragement from the children to help the one child who had the controls as they played the game. At important points in time in the game, Judy stopped the play and stimulated the children's thinking about game strategy, character, setting, and narrative elements. Ratchet and Clank Play Station game became the class text. On walls around the classroom, descriptive words were listed, and children's drawings of characters were displayed along with posters of the narrative structure. The children would play the game for 30 minutes and then Judy would teach a 30-minute English lesson on vocab, descriptive writing, grammar, and narrative elements.

Judy integrated the play station game to support curriculum outcomes in English. She used pedagogical practices that were primarily teacher-centered as evidenced by explicit instructional teaching during game play. Through directing the children's play, she focused attention to learning English elements and their relationships. Judy's choice of a play station game and her expressions about the game as a text, the impact of action, and the multimodality of games evidence multiplistic views of knowledge. She considered her competency with technology as low (Table 6.1.7).

**Table 6.1.7.** *Classification Framework of Judy's Use of Ratchet and Clank.*

Epistemic beliefs	Dualistic view	<b>Multiplistic</b>	Relativistic		Relativism	
Pedagogical beliefs	Developing computer skills & supplementing subject skills	<b>Enrich existing curriculum</b>			Facilitating new ways of learning	
Pedagogical practices with ICT	Teacher Centred	<b>Primarily Teacher Centred</b>	Mix-balanced	Primarily Student Centred	Student Centred	
Levels of learning	Doing	<b>Thinking about connections</b>	Thinking about concepts	Critiquing and evaluating	Creating knowledge	Sharing knowledge
Technological competency	<b>Low</b>	Medium			High	

**Case Study 3: Janet**

Janet split her 15 Year 5 girls into three rational groups in the library lesson. Group 1 completes a library skills task; Group 2 borrows books; and Group 3 play Kinectimals an Xbox Kinect game. Janet moves around the groups. She wants the girls to be independent learners, active, and involved in tasks. As she moves to the Xbox Kinect game, the girls are taking turns, physically moving as virtual animals in the game. There are two girls playing and the rest are seated to the side shouting instructions. The two girls playing move their arms and legs, head, and shoulders in ways that action their virtual character on the screen.

**Table 6.1.8.** *Classification Framework of Janet's Use of Kinectimals Xbox Kinect.*

Epistemic beliefs	Dualistic view	Multiplistic	Relativistic			Relativism
Pedagogical beliefs	Developing computer skills & supplementing subject skills	Enrich existing curriculum			Facilitating new ways of learning	
Pedagogical practices with ICT	Teacher Centred	Primarily Teacher Centred	Mix-balanced	Primarily Student Centred	Student Centred	
Levels of learning	Doing	Thinking about connections	Thinking about concepts	Critiquing and evaluating	Creating knowledge	Sharing knowledge
Technological competency	Low	Medium			High	

One girl is running on the spot with her arms moving up and down like she is climbing a tree. Janet asks the girls questions as they physically track animals in the game. The girls explain what they are doing and the challenges they face, and why they are hiding in the scrub or following animal tracks. It is a noisy environment of squeezels and laughter.

Janet focused on making learning meaningful and active. For her, the more students' engage actively in learning, the better the outcomes. All rotational activities were purposeful and activity based with emphasis on collaboration and inquiry. The use of the three-dimensional adventure game represented her relativistic beliefs about knowledge generation and student-centered practices, as the students were enabled to manipulate ideas and hypotheses to construct their own knowledge. She appropriated the digital game to facilitate new ways of learning as the girls became the animal virtually to learn about habitats and traits. Janet had never played the Xbox Kinect game before and let the children lead both the set up and game play (Table 6.1.8).

The short descriptions here are provided for illustration of teacher practice. Rich descriptions were developed from multiple data sources such as planning sessions, twice yearly interviews and classroom observations, and teacher's personal blogs and curriculum documentation. Greater detail and description of game-based pedagogy of these teachers and other teachers in the project are currently in the process of publication.

## **Discussion and Conclusions**

It was evident in each case that teachers' beliefs aligned with the pedagogical practices they used to direct both their choice of game and how to implement it in their classroom. These findings contribute to the research on the synergies between beliefs and practice (Ertmer et al., 2012; Kim, Kim, Lee, Spector, & DeMeester, 2013; Kordaki, 2013). In Lucy's case, her dualistic views directed her choice of a reading tutor—Reading Quest, which supported her teacher-centered approaches through skill-based tutorials. Students were engaged in building reading skills through quizzes. Likewise, Judy's Ratchet and Clank, primarily teacher-centered approach, was underwritten by multiplisitic views to support the existing curriculum. These views did not encourage her to choose an English tutorial rather she chose a play station game which replaced her "Big Book" but evidenced different epistemological beliefs from dualistic as she was seeking ways that the modality of games leveraged greater opportunities for how English concepts could be learnt. Lastly, Janet demonstrated her relativisitic beliefs through her appropriation of Kinectimals through student-driven inquiry. Her students needed to take the lead, be challenged, and do something different where they could explore as well as collaborate during game play. This suggests the claim that teacher's beliefs direct both the choice of technology and tech-nology enhanced practice.

Lucy more so than Judy used teacher-centered practices, while Janet demonstrated student-centered practices. What was evident in the application of this framework was the need for greater examination of the kinds of pedagogical practices used. Defining teacher-centered to student-centered practices is limited. Currently, the literature relies on the traditionalist-constructivist continuum to explain the variance in pedagogical appropriation of ICT. Ertmer et al. (2012) extended the continuum to include primarily teacher-centered to

primarily student-centered. However, further illustration of this middle ground needs to capture the complexity of pedagogical practice. To support greater delineation of pedagogy in this classification framework, the inclusion of Kemmis et al.'s (1977) seminal work in pedagogical models of (a) Instructional—divides the learning activities into smaller units, (b) Relevatory—presenting a series of activities in order for students to discover, and (c) Conjectual—enables students to manipulate ideas and hypotheses, in alignment with the other categories provides the researcher with greater opportunity for refinement and expression of pedagogy as shown in Table 9.

This article has sought to explore teacher beliefs and pedagogical practices in the use of digital games in the classroom. It has both developed and applied a classification framework for examining technology-enhanced practice in relation to teacher beliefs, practices, learning, and competency. The alignment of beliefs and practices was evident in the literature ranging from the traditionalist to the constructivist orientations. Underwriting this were epistemic beliefs that moved from knowledge being right or wrong to an uncertain evidenced-based construction. Students' levels of learning were considered developmental with the inclusion of sharing knowledge supported by and through technology. The adaptability and validity of the conceptual framework can be demonstrated in its application to the case studies. The focus of the framework as an analytical instrument was to examine the relationship between teacher beliefs, practice, and learning rather than the technology itself. It provides one possible lens for examining teacher beliefs, practices, and technology use but also gives greater vernacular for targeted discussion between researchers and teachers.

**Table 6.1.9.** *Classification Framework for Technology- Enabled Practice (FrameTEP)*

Epistemic beliefs	Dualistic view	Multiplistic	Relativistic	Relativism	
Pedagogical beliefs	Developing computer skills and supplementing subject skills	Enrich existing curriculum		Facilitating new ways of learning	
Pedagogical practices	Teacher-centered	Primarily teacher-centered	Mix-balanced	Primarily student-centered	Student-centered
Levels of learning	Doing	Thinking about connections	Thinking about concepts	Critiquing and evaluating	Creating knowledge
Technology competency	Low	Medium		High	

*Note,* ICT = Information and communication technology

## **Limitations and Future Research**

This article has drawn on the literature to produce a classification framework for the examination of teachers' technology-enabled practices. However, it is acknowledged that digital games have their own characteristics and complexities compared with other technologies (Boyle, Connolly, Hainey, & Boyle, 2012; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Young et al., 2012), which may lead to the development of more specific typologies. For the generalist teacher though and within the Serious Play project, digital games were considered one of the ICT tools used in the classroom. Further research is needed in both the analysis and construction of a classification framework for digital game appropriation as well as greater employment of FrameTEP as an analytical tool for teachers' appropriation of other ICT tools.

Technology-enabled practices as the cornerstone of the 21st-century classroom require teachers to constantly rethink their purposes and means by which they integrate new technologies into the teacher-learning nexus. Understanding what drives their choice of tool, how they appropriate it, and what this means for students are foundational for teachers themselves as well as those supporting their use, such as administrators and teacher educators. For all educators, a classification framework such as FrameTEP can be instrumental in helping teachers' identify current practice and giving rise to informative dialog among practitioners as well as in designing effective professional development to enable change in pedagogies. As identified in this article, each teacher chose a type of digital game based on her epistemic and pedagogical beliefs. As a starting point, FrameTEP can be used as a means of making teachers conscious of what informs both their choice of game and practice.

## **Acknowledgements**

We acknowledge the students and teachers in the Victorian and Queensland schools who are Industry Partners in this research and the Serious Play Research Team: Catherine Beavis, Michael Dezuanni, Joanne O'Mara, Leonie Rowan, Sarah Prestridge, Jason Zagami, and Yam San Chee. Research Assistance: Roberta Thompson, Christy McGillivray, and Colleen Stieler-Hunt. Statistical Consultant: Sandy Muspratt. It is also acknowledged that Carlos de Aldama was supported by the Spanish Ministry to work with Dr Prestridge for a short period to further his research into teachers' use of educational technologies.

## **Declaration of Conflicting Interests**

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## **Funding**

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Australian Research Council under Linkage Grant LP110200309: Serious Play: Using Digital Games in School to Promote Literacy and Learning in the Twenty First Century.

## References

- Anderson, L. W., & Krathwohl, D. R. (Eds.) (2001). *A taxonomy for learning, teaching, and assessing: A revision of bloom's taxonomy of educational objectives*. Boston, MA: Allyn & Bacon.
- Becker, H. J., & Riel, M. M. (2000). *Teacher Professionalism and the Emergence of Constructivist-Compatible Pedagogies*. *College Teaching Methods and Styles Journal*. Irvine: University of California, Irvine, Center for Research on Information Technology and Organizations.
- Belenky, M., Clinchy, B., Goldberger, N., & Tarule, J. (1986). *Women's ways of knowing: The development of self, voice and mind*. New York, NY: Basic Books.
- Biggs, J., & Collis, K. (1982). *Evaluating the quality of learning: The SOLO taxonomy*. New York, NY: Academic Press.
- Boyle, E. A., Connolly, T. H., Hainey, T., & Boyle, J. M. (2012). Engagement in digital entertainment games: A systematic review. *Computers in Human Behaviour*, 28, 771–780.
- Budge, K., & Cowlshaw, K. (2012). Student and teacher perceptions of learning and teaching: A case study. *Journal of Further and Higher Education*, 36(4), 549–565.
- Chai, C. (2010). Teachers' epistemic beliefs and their pedagogical beliefs: A qualitative case study among Singaporean teachers in the context of ICT-supported reforms. *The Turkish Online Journal of Educational Technology*, 9(4), 128–139.
- Chan, K., & Elliot, R. (2004). Relation analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education*, 20(8), 817–831.
- Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59, 661–686.
- Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, 57, 1469–1483.
- Downes, T., Fluck, A., Gibbons, P., Leonard, R., Matthews, C., Oliver, R., . . . Williams, M. (2001). *Making better connections: Models of teacher professional development for the integration of information and communication technology into classroom practice*. Canberra, Australia: Department of Education, Science and Training.
- Ertmer, P. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, 47(4), 47–61.
- Ertmer, P. (2005). Teacher pedagogical beliefs: the final frontier in our quest for technology integration? *Educational Research and Development*, 53(4), 25–39.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59, 423–435.
- Hadley, M., & Sheingold, K. (1993). Commonalties and distinctive patterns in teachers' integration of computers. *American Journal of Education*, 101(3), 261–315.
- Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about know-ledge and knowing* (pp. 169–190). Mahwah, NJ: Erlbaum.
- Hofer, B. K. (2001). Personal epistemology research: Implications for learning and instruction. *Educational Psychology Review*, 13(4), 353–382.

- Kember, D., & Gow, L. (1994). Orientations to teaching and their effect on the quality of student learning. *Journal of Higher Education*, 65(1), 58–74.
- Kemmis, S., Atkin, R., & Wright, E. (1977). *How do students learn?* (Occasional Publications No. 5). Norwich: Centre for Applied Research in Education, University of East Anglia.
- Keys, P. (2007). A knowledge Elter model for observing and facilitating change in teachers' beliefs. *Journal of Educational Change*, 8(1), 41–60.
- Kim, C., Kim, M., Lee, C., Spector, J., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76–85.
- Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.
- Kordaki, M. (2013, October). High school computing teachers' beliefs and practices: A case study. *Computers & Education*, 68, 141–152.
- Looi, C., Sun, D., Soew, P., & Chia, G. (2014). Enacting a technology-based science curriculum across a grade level: The journey of teachers' appropriation. *Computers & Education*, 71, 222–236.
- López-Íñiguez, G., & Pozo, J. I. (2013). The influence of teachers' conceptions on their students' learning: Children's understanding of sheet music. *British Journal of Education Psychology*, 84(2), 311–328. doi:10.1111/bjep.12026
- Loveless, A. (2011). Technology, pedagogy and education: Reflections on the accomplishment of what teachers know do and believe in a digital age. *Technology, Pedagogy and Education*, 20(3), 327–342.
- MacDonald, B., Atkin, R., Jenkins, D. R., & Kemmis, S. (1977). Computer assisted learning: Its educational potential. In R. Hooper (Ed.), *The National Development Programme in Computer Assisted Learning: The Final Report of the Director*. London: Council for Educational Technology.
- Mama, M., & Hennessy, S. (2013). Developing a conceptual framework of teacher beliefs and practices concerning classroom use of ICT. *Computers & Education*, 68, 380–387.
- Meyer, J. H., & Eley, M. G. (2006). The approaches to teaching inventory: A critique of its development and applicability. *British Journal of Educational Psychology*, 76, 633–649.
- Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19, 317–328.
- Pajares, M. F. (1992). Teacher beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62, 307–332.
- Perry, W. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York, NY: Holt, Rinehart and Winston.
- Pozo, J. I., & Postigo, Y. (2000). *Los procedimientos como contenidos escolares* [Procedures Such as School Content]. Barcelona, Spain: Edebe'.
- Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education*, 58(1), 449–458.
- Richardson, V. (2003). Pre-service teachers' beliefs. In J. Raths & A. C. McAninch (Eds.), *Teacher beliefs and classroom performance: The impact of teacher education* (pp. 1–22). Greenwich, CT: Information Age Publishing.
- Rokeach, M. (1968). *Beliefs, attitudes and values: A theory of organization and change*. San Francisco, CA: Jossey-Bass.

- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82(3), 498–504.
- Schommer, M., & Walker, K. (1995). Are epistemological beliefs similar across domains? *Journal of Educational Psychology*, 87(3), 424–432.
- Schraw, G., Bendixen, L. D., & Dunkle, M. E. (2002). Development and validation of the Epistemic Belief Inventory (EBI). In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 261–275). Mahwah, NJ: Erlbaum.
- Starkey, L. (2011). Evaluating learning in the 21st century: A digital age learning matrix. *Technology, Pedagogy and Education*, 20(1), 19–39.
- Tondeur, J., van Braak, J., & Valcke, M. (2007). Towards a conceptual framework of computer use in primary education. *Journal of Computer Assisted Learning*, 23, 197–206.
- Trigwell, K., & Prosser, M. (1996). Changing approaches to teaching: A relational perspective. *Studies in Higher Education*, 21(3), 275–284.
- Yin, R. (2009). *Case study research: Design and method (4th ed.)*. Thousand Oaks, CA: Sage.
- Young, M. F., Slota, S., Cutter, A. B., Jalette, G. M., Lai, B., Simeoni, Z., . . . Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. *Review of Educational Research*, 82(1), 61–89.

### Author Biographies

**Sarah Prestridge** is a senior lecturer in Educational Technologies, School of Education and Professional Studies at the Griffith University, Queensland, Australia. Dr Sarah Prestridge's research examines teachers' engagement in ICT professional development that intends to enable them to understand digital pedagogy and how this differs from their current practice. Current directions in this area are focused on identifying the process of changing teachers' practice through making teacher's conscious and critical of their informing beliefs.

**Carlos de Aldama** is an educational psychologist and PhD candidate at Autonomous University of Madrid, Spain. He has researched in different fields of motivation, such as sport psychology. His current interests include research relating to teacher beliefs and the study of ICT as learning tools, specifically the integration of new technologies in formal education.



## ***Estudio II-Artículo II***

---

de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, *Electronic Journal of Research in Educational Psychology*

### Abstract

**Introduction.** Several studies show that one of the essential factors in the way teachers use Information and Communication Technologies (ICT) in their lessons are the beliefs they hold regarding ICT as tools for teaching and learning. This study analyses the relationship between these beliefs and the way teachers use ICT in the classroom through design of a *System of Categories for the Analysis of Beliefs about and Uses of ICT*.

**Method.** We applied an open-ended questionnaire about beliefs and uses of ICT to 16 teachers of Child and Primary Education and collected 42 activities proposed by them where ICT were crucial. To analyse the answers, we designed a *System of Categories for the Analysis of Beliefs about and Uses of ICT*, based on three essential dimensions: what teachers said they taught, the psychological processes they activated in their students and the activities or tasks they proposed to achieve that learning.

**Results.** The results indicate that there is a wide gap between the beliefs teachers hold and the way they actually use ICT. While they said that ICT should be used to make learning more student-centred and to foster motivation, most of the activities proposed were aimed at one-directional conveyance of contents, and were neither highly developed nor did they noticeably transform traditional ways of teaching.

**Conclusions and Discussion.** The paper concludes with a few reflections and suggestions about how ICT could really be integrated in the classroom based on a new learning culture.

**Keywords:** educational beliefs, pedagogical practices, teacher ICT use, technology integration

## Resumen

**Introducción.** Numerosos estudios muestran que un factor clave para explicar la forma en que los docentes usan las Tecnologías de la Información y Comunicación (TIC) en las aulas son las creencias que mantienen en relación con estos dispositivos como herramientas de enseñanza y aprendizaje. Este trabajo analiza la relación entre esas creencias y el uso que hacen los docentes de las TIC en el aula a través del diseño de un *Sistema Categorical para el Análisis de las Creencias y Usos de las TIC*.

**Método:** Aplicamos un cuestionario de preguntas abiertas sobre creencias y usos de las TIC a 16 docentes de Infantil y Primaria y analizamos 42 actividades propuestas por ellos donde las TIC tuvieran un papel relevante. Para analizar las respuestas, diseñamos un *Sistema Categorical para el Análisis de las Creencias y Usos de las TIC*, basado en tres dimensiones fundamentales: qué es lo que los profesores dicen enseñar, qué procesos psicológicos activan en sus estudiantes y las tareas o actividades que proponen para alcanzar sus objetivos de aprendizaje.

**Resultados:** Los resultados indican que existe una distancia considerable entre las creencias sostenidas por los profesores y el uso educativo que realmente hacen de las TIC. Mientras que los profesores afirman que las TIC son buenas herramientas para diseñar entornos de aprendizaje significativos centrados en el alumno, la mayoría de las actividades propuestas favorecen formas de enseñanza tradicionales centradas en el contenido.

**Conclusiones y discusión:** El artículo concluye con algunas reflexiones y sugerencias para una verdadera integración de las TIC en el aula basada en una nueva cultura del aprendizaje.

**Palabras clave:** creencias educativas, prácticas pedagógicas, uso de las TIC, integración tecnológica.

## Introduction

The study of ICT as tools for designing significant teaching and learning scenarios has been widely dealt with in recent years (Hadjithoma & Karagiorgi, 2009; Monereo, 2004; Thompson, 2013). Despite the fact that there are opposing positions regarding the educational potential of ICT, usual discourse, whether political, educational or social (Coll & Monereo, 2008; Ertmer, 2005), associates them to processes of change and improvement in educational quality. Coll & Monereo (2008) highlight their qualities as tools for thinking and inter-thinking – instruments of symbolic nature offering unprecedented possibilities for accessing, finding, processing, conveying and sharing information.

However, most studies conducted to date on integrating ICT in classrooms systematically point out that merely introducing them into the classroom will not in itself guarantee educational transformation and improvement (Coll & Monereo, 2008; Cuban, Kirpatrik & Peck, 2001; Ertmer, 1999). Peggy Ertmer (1999) describes the obstacles to including ICT in the classroom as type I and type II barriers. Type I barriers are anything to do with the type of resources (equipment, time, training, support, etc.) to which the teacher has access. They are the first obstacle that needs to be overcome for true integration of ICT in the classroom. Type II barriers are less tangible, yet determinant, in the opinion of some authors (Fisher, Dwyer & Yocam, 1996), and refer to the type of belief, often in the form of an “implicit theory” (Pozo et al., 2006), which the teacher holds with regard to teaching, learning and acquisition of knowledge. Below, we shall analyse in more detail the nature of these beliefs, reflect on different uses of ICT in the classroom, and finally, try to establish links between them.

### *Educational beliefs held by teachers*

The concept of teachers’ beliefs is a recurring topic in research into education (Nespor, 1987; Pajares, 1992). Although it is a difficult concept to define, there are many agreements regarding it. An initial approach would be the definition proposed by Richardson (2003), who defines beliefs as psychological representations, premises or propositions that an individual feels are true. They are relatively stable, develop based on personal experiences which compromise us emotionally, and help us see and understand the world in a given way (Pajares, 1992).

Teachers’ educational beliefs, psychology and intuitive pedagogy (Olson & Bruner, 1996; Pozo et al., 2006) are implicit or explicit representations of individuals, objects and events, and the relationship among them within the educational context (Hermans, van Braak & van Keer, 2008). They develop over years of experience, ranging from life as a student at school (Richardson, 2003) to the different practices involved in professional performance as a teacher (Prestridge, 2012). This is why beliefs are stable and often resistant to change, though not impossible to modify. As noted by Prestridge (2012), in the context of change of teaching practice, professional development is successful when it promotes a change in beliefs (from teacher-centred to student-centred) by making them explicit and raising awareness, or by the teacher’s reflection on his/her own practice (Schön, 1987).

Scientific literature has often classified educational beliefs along a continuum, with more traditional, mainly teacher-centred beliefs at one end, and more progressive, constructivist, student-centred beliefs at the other (Cox & Webb, 2004; Kerlinger & Kaya, 1959a, 1959b). In the former, the teacher is in charge of conveying clearly defined knowledge, and the quality of learning is measured by the student's capacity to acquire and reproduce this knowledge as faithfully as possible. In the latter case, the teacher mediates the learning process, which emerges from sharing dialogue and reflection with the students, and thus, knowledge is a progressive construction rather than a given.

Focusing more specifically on beliefs regarding the use of ICT, Ertmer (1999, 2005) classifies pedagogical beliefs about ICT as educational tools into three categories: 1) as a complement to the syllabus, for motivating students and developing their skills, 2) as support to the existing syllabus, where ICT would be an educational tool for teaching content, fostering cooperation among the different agents and promoting elaborate thinking, and 3) as tools fostering the emergence of a new syllabus adapted to the demands of the twenty-first century, where the student must change the way he learns. Similarly, Prestridge (2012) distinguishes four pedagogical beliefs regarding the use of ICT as educational tools: 1) to develop technical skills for using the device (using mouse, keyboard, interactive whiteboard, etc); 2) to perform functional activities (such as using a text processor), 3) to suggest tasks that extend and enrich the existing syllabus, and 4) to promote and explore new areas of teaching and learning. In the same vein, Mama and Hennessy (2013) suggest a similar classification, but add a belief type ("subversive") which includes the fear that ICT often produce in teachers.

#### *Uses of ICT in the classroom*

A number of definitions, classifications and typologies have been developed within the context of educational use of ICT (Tondeur, van Braak & Valcke, 2007). For example, Prestridge (2012) conducted a study using the "Digital Age Learning Matrix" designed by Starkey (2009) where the author compared possible uses of ICT (accessing, presenting, processing, playing and communicating information) and learning levels promoted, which were, from least to most complex, doing, thinking about connections, thinking about concepts, criticising and evaluating, creating knowledge and sharing knowledge. Tondeur van Braak and Valcke (2007) conducted a factorial analysis on a sample of 352 primary school teachers, with the aim of developing a possible typology of uses at that educational level. The structure found revealed three factors: one referring to the use of ICT as information tools, another as learning tools, and a third focusing on developing basic skills (psychomotor). Coll and Monereo (2008) designed a typology of uses focusing on the teacher-learner-content interactive triangle, in an effort to overcome those focusing only on ICT potentialities and characteristics (Squires & McDougall, 1994) or on major pedagogical and didactic issues (Salomon, Perkins & Globerson, 1991). They also avoided neutral description (as in Twining, 2002), taking a firm stand from the socio-constructivist approach, which serves as reference for identifying the principal dimensions of educational practice.

We believe that the interactive triangle among teaching activity, contents of learning and student activity to acquire them is highly relevant. Therefore, as described below, we distinguish among three basic components present in any learning/teaching activity (Pozo, 2008): *outcomes* (what is learned), *processes* (the cognitive activity by means of which learning takes place, subdivided into two aspects, namely, the cognitive processes activated and the type of processing done with ICT, in a very similar vein to the uses suggested by Prestridge, 2012) and *conditions* (the teaching tasks or activities through which learning takes place), which are described in depth in the Methodology section.

Different uses of ICT have been identified through these different typologies, although in most cases their complexity is rather low. The famous study by Cuban et al. (2001) noted the little-developed educational uses to which teachers put ICT, even when almost complete technological infrastructure is available to them. The authors note that practice was characterised by simple use of ICT based on text processing and as a support to their lectures. These uses seemed to foster the conservation of traditional teaching models rather than their transformation.

More recently, Sigalés, Mominó, Meneses and Badia (2008) wrote an exhaustive report about the integration of internet in education in Spain. They say, *"When teachers use ICT, it is primarily to convey contents and guide student learning. And when students use ICT, it is primarily to access contents and produce documents with content. Clearly, when teachers and students use ICT in class, it is usually content-related, making use mainly of information technologies, and to a much lesser extent, making use of communication technologies and the recently named learning technologies"* (p.175). It seems that the oft-mentioned technological revolution barely manages to break through the walls of schools (Coll & Monereo, 2008). Can teachers' educational beliefs provide any clues to the reason for this?

#### *Teachers' educational beliefs and how they relate to the use of ICT in the classroom*

Ertmer (2005) believes that once extrinsic barriers (technological infrastructure, technical support, etc.) have been overcome, teachers' beliefs are a key factor for integrating ICT in the classroom. Many papers report a positive relationship between constructivist conceptions and the active use of technology (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Hermans, Tondeur, van Braak & Valcke, 2008; Kim, Kim, Lee, Spector & DeMeester, 2013; Niederhauser & Stoddart, 2001). For example, Cox and Webb (2004) analysed teachers' perceptions of ICT during the teaching process, based on the instructional/constructivist model, and conclude that constructivist stances favoured the use of ICT in the classroom. In the same vein, Sang, Valcke, van Braak and Tondeur (2010) found that teachers who held strong constructivist pedagogical beliefs were more receptive to integrating ICT in the classroom than teachers who did not hold these beliefs.

Otherwise, some studies have found inconsistencies between teachers' pedagogical beliefs and the activities they proposed (Liu, 2011; Zhao & Cziko, 2001). Teo, Chai, Hung and Lee (2008) studied teachers in Singapore, and found a positive correlation between constructivist beliefs and both constructivist and traditional practices, although traditional

beliefs were negatively correlated to constructivist practices. Tondeur, Hermans, van Braak and Valcke(2008) conducted a study on 574 primary school teachers and concluded that those who held strong beliefs, whether traditional or constructivist, used ICT in the classroom more often. Liu (2011) used questionnaires to analyse beliefs and practices with ICT in 1139 primary school teachers in Taiwan, concluding that although most teachers hold learner-centred beliefs, the way in which they integrate technology in the classroom diverges from constructivist practices.

The beliefs teachers hold and the way they use ICT seem to depend on certain variables. Several studies claim that these variables allow the different teacher approaches to ICT to be predicted (Mumtaz, 2000; Peek et al., 2014; van Braak, 2001). Gender, for example, is one of the most frequently studied variables (Vekiri 2010; Volman, van Eck, Heemskerk & Kuiper, 2005). Vekiri and Chronaki (2008) found that computer-mediated activities at school were central to male students much more often than to females. Similarly, males had much higher perceptions of self-efficacy. However, Iniesta-Bonillo, Sánchez-Fernández and Schlesinger (2013) found no significant difference with regard to access and frequency of use, although they did find differences regarding their complexity. Females usually used ICT in more elaborate ways than males.

Age is another factor that has often been analysed (Drent & Meelissen, 2008; Jamieson-Proctor, Watson, Finger, Grimbeek & Burnett, 2007). Inan and Lowther (2010) found in a sample of 1382 teachers that age was negatively related to competence in the use of computers, making their integration in the classroom difficult, and possibly reflecting the fact that the digital gap is also a generation gap. However, these differences in uses do not imply radically different ways of learning between youths and adults (Margaryan, Littlejohn & Vojt, 2011).

Howard, Chan and Caputi (2014) analysed different areas or disciplines of teacher specialisation and their relationship with educational beliefs, a key variable for predicting integration of ICT in the classroom. The results showed that teachers of English as a foreign language considered ICT more important as educational tools than science teachers did. Tamim, Borokhovski, Abrami and Schmid (2011) conducted a second order meta-analysis of the research performed over the past 40 years on the integration of ICT in educational contexts, concluding that there are factors specific to each discipline which may condition that integration, e.g. the fact that mathematics often uses graphs (Hennessy, Ruthven & Brindley, 2005), sciences use visual representations (Cox & Webb, 2004) and language and writing development in English (Silvernail & Gritter, 2007).

Having situated the reader in the scenario of beliefs and educational uses of ICT, we shall now briefly describe the aims of our study.

### *Study aims*

The aims of this study are to:

1. Design a System of Categories for the Analysis of Beliefs about and Uses of ICT which will allow us to look in depth at concrete aspects that other typologies do not reflect (Mama and Hennessy, 2013; Prestridge, 2012; van Braak, Tondeur and Valcke, 2004).

2. Identify teachers' educational beliefs regarding ICT as instruments for teaching and learning.

3. Identify the ways in which teachers use ICT in the classroom context.

4. Determine whether there is consistency between teachers' educational beliefs regarding ITC and the ways in which they use them in the classroom.

5. The final aim (though only exploratory, due to the sample size) is to analyse the influence that certain variables such as age (Drent & Meelissen, 2008), gender (Volman et al., 2005), subjects taught (Howard et al., 2014) and educational level (Pelgrum, 2001) may have on educational beliefs and use of ITCs.

### **Method**

#### *Participants*

We used a sample of 16 teachers of Child and Primary Education (12 female, 4 male,  $\bar{X}$  = 31.6 years, S.D = 6.2) that represents 47% of teacher's population from one school, which has the following characteristics:

- Newly built school (inaugurated in 2009).
- Young teaching staff, trained and with little experience.
- Interest in methodological and didactic innovations.
- Decidedly focused on using ICT as learning tools: all classrooms had a video projector or an interactive whiteboard and at least three laptop or desktop computers.

We thought that this school would be suitable as a reference regarding innovative practices in the use of ICT because its approaches to type I barriers (technological access and infrastructure) and type II barriers (teachers' educational beliefs) seemed to foster adequate integration of ICT in the classroom (Ertmer, 1999).

#### *Instrument for data collection*

In order to gather the information of interest, we prepared a questionnaire made up of open-ended questions, comprising two parts:

1. Initial question (*Educational Beliefs*): a general question about teachers' beliefs regarding ICT as instruments of change in teaching and learning processes.
2. Concrete activities (*Uses of ICT*): in this section we asked the teachers to describe in detail the three most important activities conducted in the classroom in which the



teaching and learning processes were mediated by ICT. Specifically, we asked them to specify the teaching and learning aims proposed for the task, the roles played in it by teachers and students, and how they behaved when a difficulty arose during the course of the activity (regarding behaviour, learning, etc.).

#### *Procedure*

Part of research team arranged an appointment with the school principal to explain the aims of the study and the procedure. He requested his staff to respond the questionnaire and sent it to them via email. Teachers got around a week to answer it and afterwards they should to send back to the research team via email too. We chose this questionnaire as instrument for data collection because we thought it was the best procedure to let teachers think about their own experiences. In addition, we arranged interviews with some of them in order to clarify certain points of their answers to the questionnaire.

#### *Data analysis*

As mentioned above, the main aim of the study was to provide empirical evidence that would enable us to look more deeply into the relationship between teachers' educational beliefs and uses of ICT in the classroom. Our intention was to design an instrument for analysis which would allow the study of relevant aspects on which there is not much research to date. Based on previous studies of the research team in other areas (Casas, Montero & Pozo, 2015; López-Iñíguez & Pozo, submitted; Pozo & Postigo, 2000), we developed this instrument paying attention to four main dimensions: 1) Learning Outcomes, focusing on the learning aim set by the teacher for students through an activity, 2) Information Processing, a category conceived for evaluating the cognitive demand of the proposed activities 3) Psychological Processes that the teacher intended to activate in the students, and 4) Learning Conditions, with reference to analysis of the context in which the ICT-mediated activity took place (Pozo, 2008).

The following chart summarises each category in the System of Categories for the Analysis of Beliefs about and Uses of ICT.

**Table 6.2.1. Learning Outcomes**

A. Learning Outcomes							
This category focuses on the learning aim set by the teacher for the students through an activity.							
A.1 Verbal learning		A.2 Procedural learning		A.3 Attitudinal learning			
Handling symbolic codes (language, numbers, maps. “Know how to say”.		Learning ordered actions directed towards a goal. “Know how to do”.		Learning relatively stable and long-lasting ways of evaluating objects, persons or events, and ways of acting consistently with them (Sarabia, 1992).			
A.1.1	A.1.2	A.2.1	A.2.2	A.3.1	A.3.2		
Information	Understanding	Techniques	Strategies	To knowledge	Social		
Facts and data. Precise assimilation. “All” or “nothing” learning.	Learning about concepts relationships between facts and data.	Repetitive practice and absence of reflection.	Reflective practice. Metacognitive processes, planning, goals and evaluation.	Attitudes related to how we interact with information and knowledge.	Attitudes related to how we interact with others.		
				A.3.1.1	A.3.1.2	A.3.2.1	A.3.2.2
				Passive	Active	Competitive	Supportive
				Without cognitive and affective implication.	With cognitive and affective implication.	“Winner-loser” dichotomy.	Mutual help. Cooperation.

**Table 6.2.2. Information Processing**

<i>B. Information Processing</i>				
This category evaluates the cognitive demand of the activities proposed, i.e. what kind of mental operations and cognitive resources students must put in motion to resolve the activity satisfactorily. We used the typology developed by Pozo and Postigo (2000).				
<i>B.1 Acquisition</i>	<i>B.2 Interpretation</i>	<i>B.3 Analysis</i>	<i>B.4 Comprehension and Organisation</i>	<i>B.5 Communication</i>
Acquiring new information. Procedures of finding, gathering, selecting and maintaining information.	Transcribing information to a new code or comparing it to a model in order to be able to work with it.	Drawing conclusions. Involves inferences and deductive-inductive procedures.	Simultaneous relationship of present and non-present information. Specific procedures for organization (outlines, conceptual maps, summaries, etc.).	Conveying, exchanging and contrasting information among students.

**Table 6.2.3. Psychological Processes**

<i>B. Psychological Processes</i>			
This category analyses the psychological processes that teachers say they consider when they propose their activities.			
<i>C.1 Memory</i>	<i>C.2 Attention</i>	<i>C.3 Motivation</i>	<i>C.4 Metacognitive Processes</i>
Storing and retrieving information.	Focusing cognitive resources.	Setting in motion cognitive and affective resources to perform a task.	Becoming aware of the various aspects of mental activity: planning, evaluation, defining goals, etc.

**Table 6.2.4. Learning Conditions**

<p>D. Learning conditions</p> <p>In this category we have grouped relevant aspects regarding “how” the ICT-mediated teaching and learning activity has been carried out.</p>	<p><i>D.1 ICT Support</i> “Hardware” through which the activity proposed by the teacher materializes.</p>	<i>D.1.1 Projector/Interactive whiteboard</i>
		<i>D.1.2 Portable computer</i>
	<p><i>D.2 What ICT are used for</i> “What is done with ICT” in the classroom.</p>	<i>D.2.1 Accessing information</i> Following preset steps to make specific information available.
		<i>D.2.2 Presenting information</i> Showing given information considered interesting, whether it is essential or complementary to the contributions of teacher and/or student.
		<i>D.2.3 Finding information</i> Accessing given sources to select and contrast specific information.
		<i>D.2.4 Gaming and entertainment</i> Fun and recreational aims.
		<i>D.2.5 Producing contents</i> Developing some kind of product.
	<p><i>D.3 Task complexity</i> Level of difficulty of the task. Number of possible solutions, degree of uncertainty to be worked with or student manoeuvring leeway.</p>	<i>D.3.1 Closed task</i> Single solution, low uncertainty and manoeuvring leeway for the student.
		<i>D.3.2 Open task</i> Multiple solutions, high uncertainty and student autonomy.
	<p><i>D.4 Control of task</i> Who is ultimately responsible during the course and development of the activity.</p>	<i>D.4.1 Student</i>
		<i>D.4.2 Teacher</i>
		<i>D.4.3 ICT</i>
		<i>D.4.4 Shared</i>
	<p><i>D.5 Social organisation</i> Distribution of students in the classroom and type</p>	<p><i>D.5.1 Individual</i> The activity is performed alone, with hardly any student-teacher</p>

	of relationship between them, determined by the activity itself.	interaction.
		<i>D.5.2 Group</i> The activity is performed in a group (two or more persons) without the need for cooperation among agents.
		<i>D.5.3 Cooperative</i> The activity is performed in a group (two or more persons), and requires cooperation to attain the aim of the task.
		<i>D.5.4 Undefined</i> Not enough information to determine it.

### *Classification of teachers' educational beliefs and use of ICT*

Once the definite categories were defined, we analysed teachers' discourse. To do so we applied the categories we designed to each teachers' answers according to their educational beliefs and the 42 activities collected that represented the uses of ICT. This was done in duplicate, independently by two of the researchers on the team. Cohen's  $\kappa$  was run to determine if there was agreement between them. According to Landis & Koch (1977), there was a substantial and almost perfect agreement respectively,  $\kappa = .750$ ,  $p < 0, 01$  (in the case of educational beliefs sections) and  $\kappa = .875$ ,  $p < 0, 01$  (in the case of uses of ICT)

The results shown below correspond to the number/percentage of cases assigned to the different levels of each category (over a total 16 teachers for the Initial Question and 42 for Activities), taking into account that each case could only be assigned once (e.g. even if one teacher spoke several times within a single activity about an "active attitude" in the student, it would only be considered once within that activity). Except for some of the levels, such as attitude to knowledge, type of support or task complexity, the levels were not mutually exclusive. For example, a single task could demand both acquiring and interpreting information. Finally, the information gathered was processed using QDAMiner software. Results are presented below.

## **Results**

### *Teachers' educational beliefs*

The Fig 6.2.1 shows that over half the teachers (56.25%) perceive ICT as good for motivating students, who must take responsibility for their own learning by acquiring an active attitude towards it (50%). We illustrate it with the following example: T1: *"[...] ICT are changing teaching and learning processes because there are many different possibilities and students feel attracted and motivated by them. In addition, ICT let students to become active entities and learn by experimentation"*

Teachers point out that ICT have revolutionised the way of accessing information (50%), making available to us whatever we are interested in, whenever we want it.. Aware of the demands of the Information Society, teachers see ICT as an opportunity to develop student learning strategies (43.75%) through activities controlled by students themselves (37.5%).The quotation presented below is an example:

T2:*"[...] with ICT students can self-assessment....and also they are useful for self-learning. Students are changing from being just consumers to become creators"*.

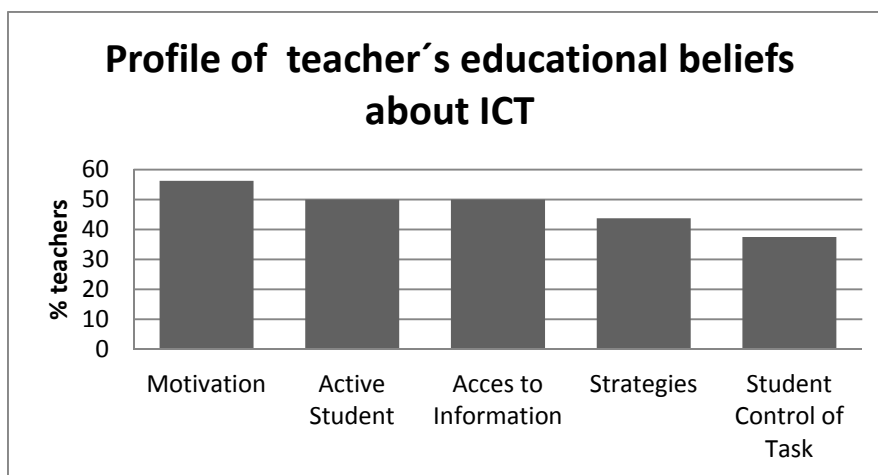


Fig.6.2.1. Profile of teachers' educational beliefs

#### Teachers' uses of ICT

The Fig. 6.2.2 shows that most of the activities proposed by teachers involve acquiring information (92.82%) in closed instructional contexts (73.78%), as we showed in next example: T3: "One activity that I propose to my students is that they have to recognize in a map projected on a digital blackboard different elements (like rivers, jungles, deserts, etc)". Similarly, teachers say they use ICT mainly for presenting information (57.12%) in groups (52.36%), where students have to assimilate the data and facts presented as faithfully as possible (61.9%). See the following example: T4: "I use ICT to show videos, which aim is knowing different places. Later, I ask to the whole class what they have learnt."

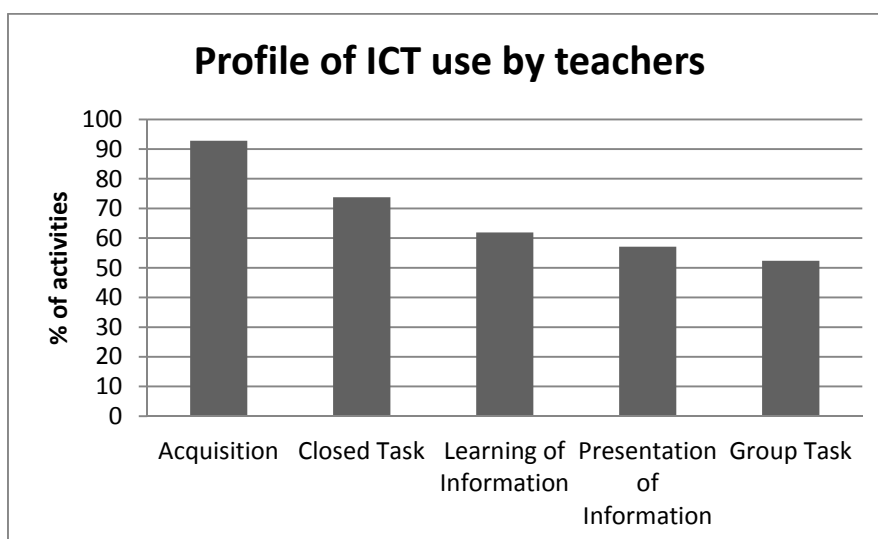


Fig.6.2.2.Profile of ICT use by teachers

### *Conclusions about teachers' educational beliefs and uses of ICT*

Although teachers perceive the educational potential of ICT, showing favourable attitudes that promote their integration in the classroom, the fact is that in most cases, the activities proposed make little use of those opportunities. There are few situations in which the student really has to put into motion highly complex cognitive and affective resources, the tasks being limited to merely mechanical matters such as memorising or retrieving information. As noted by Cuban et al. (2001), the introduction of ICT to the classroom seems to lead to the reinforcement of existing educational practices rather than their transformation,

Below, we shall describe teachers' global discourse, focusing on variables where we have found significant differences in some aspect. These variables are "Subjects Taught" ("Generalist" teachers who teach subjects such as Maths, Language, or Social Studies and "Specialist" teachers who teach subjects such as Music, English as a foreign language, or Physical Education) and "Educational Phase" (teachers of Child Education or Primary Education).

#### *Teachers' educational beliefs according to subjects taught*

Table 6.2.5 shows the characteristics that teachers highlighted for ICT as educational tools, according to subjects taught.

**Table 6.2.5.** *Teachers' educational beliefs according to subjects taught*

		Generalists (max = 8)		Specialists (max = 8)		Chi-square	P value
Learning outcomes	Techniques	0.0%	1	12.5%		1.067	0.302
	Strategies	3 37.5%	4	50.0%		0.254	0.614
	Attitude to knowledge - active student	4 50.0%	4	50.0%		0	1
Psychological processes	Motivation	5 62.5%	4	50.0%		0.254	0.614
Learning conditions	Accessing information	3 37.5%	5	62.5%		1	0.317
	Student	3 37.5%	3	37.5%		0	1

The  $\chi^2$  test at 95% confidence level shows that there is no significant difference between the discourse of Generalist and Specialist teachers. Many teachers highlight *learning strategies* (three of the eight Generalists and four of the eight Specialists) as the main goal of using ICT in the classroom, which contrasts with the almost complete absence of teachers who think of ICTs as tools for learning technical procedures (no Generalist and only one Specialist). The main goal involves an *active student* (four of the eight teachers in both cases), often responsible for controlling the task (three of the eight teachers in both cases), who uses ICT to *access information* (three and five of the eight teachers respectively). *Motivation*, in this case, takes on a highly relevant role (five of the eight Generalist teachers and four of the eight Specialist teachers).



*Teachers' use of ICT according to subjects taught*

Table 6.2.6 shows the characteristics of ICT-mediated activities proposed by teachers according to subjects taught.

**Table 6.2.6.** *Teachers' uses of ICT according to subjects*

		Generalists (max = 23)		Specialists (max = 19)		Chi-square	P value
Learning outcomes	Information	16	69.6%	10	52.6%	1.265	0.261
	Techniques	9	39.1%	6	31.6%	0.258	0.611
	Strategies	2	8.7%	8	42.1%	6.402	<b>0.011</b>
Information processing	Acquisition	22	95.7%	17	89.5%	0.599	0.439
	Interpretation	3	13.0%	9	47.4%	6.007	<b>0.014</b>
	Communication	2	8.7%	7	36.8%	4.896	<b>0.027</b>
Psychological processes	Motivation	1	4.3%	1	5.3%	0.019	0.89
	Metacognitive	1	4.3%	6	31.6%	5.555	<b>0.018</b>
Learning conditions	Accessing information		0.0%	4	21.1%	5.352	<b>0.021</b>
	Presenting information	13	56.5%	11	57.9%	0.008	0.929
	Closed	21	91.3%	10	52.6%	8.05	<b>0.005</b>
	Open	2	8.7%	8	42.1%	6.402	<b>0.011</b>
	Student	5	21.7%	8	42.1%	2.019	0.155
	Teacher	11	47.8%	5	26.3%	2.041	0.153
	ICT	6	26.1%	5	26.3%	0	0.987
	Group	13	56.5%	9	47.4%	0.349	0.554

The  $\chi^2$  test at 95% confidence level shows that the activities proposed by the two groups differ significantly in *learning outcomes*, *processing information*, *psychological processes* and *learning conditions*. Most teachers design tasks whose aim is *learning information* (69.6% of generalist proposals, and 52.6% of specialist proposals) through *processes of acquisition* (95.7% and 89.5%, respectively). They usually proposed *close activities* (91.3% and 52.6% respectively) based on *presenting information* (56.6% and 57.9%, respectively).

However, there are noticeable differences in the use of ICT by Generalist and Specialist teachers. The former design more frequently *open tasks* (8.7% in Generalist teachers and 42.1% in Specialist teachers,  $\chi^2$  (1, N=16) = 6.402;  $p$  = 0.011 where learning outcomes are *strategies* (8.7% of Generalist proposals compared to 42.1% of Specialists,  $\chi^2$  (1, N=16) = 6.402;  $p$  = 0.011 through processes more demanding, like *Interpretation* (13% of the Generalist teacher activities and 47.4% of Specialist teacher activities,  $\chi^2$  (1, N=16) = 6.007;  $p$  = 0.014 or *Communication* (8.7% and 36.8%, respectively, ( $\chi^2$  (1, N=16) = 4.896;  $p$  = 0.027)). The latter proposed more *closed activities* (91.3% of the activities of Generalist teachers and 52.6% of the activities of Specialist teachers,  $\chi^2$  (1, N=16) = 8.05;  $p$  = 0.005).

*Conclusions about teachers' educational beliefs and uses of ICT according to subjects taught*

Although there is a gap between what teachers think and what they say they put into practice, we should distinguish between groups. The gap is very wide in Generalist teachers. On the one hand, they conceive ICT as useful tools to *learn strategies*, where the student, *motivated* by using them, is *active* and in *control of the task*. On the other hand, they propose tasks that are mostly closed, mainly teacher-directed, where the main aim is to *acquire information*,

The gap is smaller in Specialist teachers. Their theoretical discourse, which is similar to that of Generalist teachers, is largely accompanied by consistent practices. The activities proposed often involve *learning of strategies*, which requires information to be processed differently from mere *acquisition* and taking into account *metacognitive processes*. Many tasks are *open*, where the student is in control, and often needs to *cooperate* with classmates.

In short, although there is a gap between what teachers believe and what they say they put into practice, in Specialist teachers the real model largely approaches the ideal model.

*Teachers' educational beliefs according to educational stage*

Table 6.2.7 shows the ICT characteristics highlighted as educational tools by teachers according to educational stage.

**Table 6.2.7.** *Teachers' beliefs according to educational stage*

		1 = child and first cycle primary school (max = 8)		2 = second and third cycle primary school (max = 8)		Chi- square	P value
Learning outcomes	Techniques		0.0%	1	12.5%	1.067	0.302
	Strategies	3	37.5%	4	50.0%	0.254	0.614
	Attitude to knowledge –active student	5	62.5%	3	37.5%	1	0.317
Psychological processes	Motivation	4	50.0%	5	62.5%	0.254	0.614
Learning conditions	Accessing information	1	12.5%	7	87.5%	9	<b>0.003</b>
	Student	4	50.0%	2	25.0%	1.067	0.302

The  $\chi^2$  test at 95% confidence level shows one significant difference between the discourses of Child Education and First Cycle Primary School teachers on the one hand, and Second and Third Cycle Primary School teachers on the other, regarding the use of ICT. The latter say that ITCs have revolutionised the way of accessing information significantly more than the former,  $\chi^2 (1, N=16) = 9, 00; p = 0.003$ .

In the rest of the dimensions, teachers' behaviour is very similar to that described above regarding *the subjects taught*: many of them desire *acquiring strategies* as learning

outcome (three of the eight Child and First Cycle Primary School Teachers, and four of the eight Second and Third Cycle Primary School teachers), through activities where the student must be *active* (five and three of the eight teachers, respectively), taking *control* of the task thanks to the ICT (four and two of the eight teachers, respectively). In this case they also highlight the intrinsic capacity of ICT to *motivate* (four and five of the eight teachers, respectively).

#### *Teachers' use of ICT according to educational stage*

Table 6.2.8 shows the characteristics of ICT-mediated activities proposed by teachers according to educational stage.

**Table 6.2.8.** *Teachers' uses of ITC according to educational*

		1 = child and first cycle primary school (max = 22)		2 = second and third cycle primary school (max = 20)		Chi- square	P value
Learning outcomes	Information	13	59.1%	13	65.0%	0.155	0.694
	Understanding concepts		0.0%	1	5.0%	1.127	0.288
	Techniques	8	36.4%	7	35.0%	0.008	0.927
	Strategies	4	18.2%	6	30.0%	0.807	0.369
Information processing	Acquisition	21	95.5%	18	90.0%	0.47	0.493
	Communication	2	9.1%	7	35.0%	4.177	<b>0.041</b>
Learning conditions	Presenting information	13	59.1%	11	55.0%	0.072	0.789
	Finding information	2	9.1%	8	40.0%	5.517	<b>0.019</b>
	Closed	20	90.9%	11	55.0%	6.988	<b>0.008</b>
	Open	2	9.1%	8	40.0%	5.517	<b>0.019</b>
	Student	5	22.7%	8	40.0%	1.462	0.227
	Teacher	9	40.9%	7	35.0%	0.155	0.694
	ICT	8	36.4%	3	15.0%	2.473	0.116
	Shared control	1	4.5%	3	15.0%	1.329	0.249
	Individual	6	27.3%	3	15.0%	0.937	0.333
	Group	13	59.1%	9	45.0%	0.834	0.361
	Cooperative	2	9.1%	4	20.0%	1.018	0.313
	Undefined	1	4.5%	5	25.0%	3.58	0.058

The  $\chi^2$  test at 95% confidence level shows that the activities proposed by the two groups differ significantly regarding *processing information* and *learning conditions*.

*Learning outcomes* show that in most cases teachers propose activities that foster learning information (59.1% for Child and First Cycle Primary School teachers and 65% for

Second and Third Cycle Primary School teachers) and with regard to *procedures*, they mostly propose *techniques* rather than *strategies*.

With regard to *processing information*, most of the activities proposed by teachers require processes of *acquiring information* (95.5% of tasks presented by teachers of Child and First Cycle Primary School and 90% of the tasks presented by Second and Third Cycle Primary School teachers). Nevertheless, the significant differences in this dimension appear in *communication*,  $\chi^2 (1, N=16) = 4.177$ ;  $p = 0.041$ . While the former rarely design activities where the aim is to share the information acquired and/or prepared (9.1%), in the latter, this percentage is higher, at 35%. However, when we apply the Fisher's exact statistical test correction this difference is not significant ( $p = 0.062$ ).

Regarding *use of ICT*, more than half the teachers' proposals use ICT for *presenting information* (59.1% and 55%, respectively). However, the significant differences between groups are found in *finding information*,  $\chi^2 (1, N=16) = 5.517$ ;  $p = 0.019$  (9.1% and 40%, respectively). This result is consistent with what was found for *complexity of the task*, where there are significant differences for both *closed* tasks (90.9% of the activities proposed by Child Education and First Cycle Primary School teachers, and 55% of proposals from Second and Third Cycle teachers,  $\chi^2 (1, N=16) = 6.988$ ;  $p = 0.008$ , and for *open* tasks (9.1% and 40% respectively,  $\chi^2 (1, N=16) = 5.517$ ;  $p = 0.019$ ). In other words, the results seem to indicate that teachers of older children carry out activities in the classroom involving significantly more complex use of ICT by the students.

#### *Conclusions about teachers' educational beliefs and uses of ICT according to educational stage*

Again, there are major differences between what teachers think and what they say they do with ICT. They say they highlight students *acquiring strategies* through *active* role and taking responsibility for *controlling the task*. The *ability to motivate* would be the added value of the ICT, whose main use would be directed to *accessing information*. The second case, however is different. Most of the activities proposed demand *acquiring information* (rather than strategies) *which is presented* (rather than accessed). Although there are some open tasks, most of them are closed, which implies a reduction in learner *control* and *active attitude*. *Motivation* is rarely mentioned (no reference in Child Education or First Cycle Primary School, and 10% in Second and Third Cycle Primary School). The following is a summary of the results.

**Table 6.2.9. Summary of results**

Teachers' educational beliefs		Teachers' use of ICT			
Subjects taught	Educational Stage	Subjects taught		Educational stage	
✓No significant difference	✓2nd and 3rd Cycle Primary: Accessing Info	Specialists	Generalists	Child and 1st Cycle Primary	2nd and 3rd Cycle Primary
		✓Learning outcome	✓Learning outcome	✓Processing Info	✓Processing Info
		✓Processing Info	✓Processing Info	✓Uses of ICT	✓Uses of ICT
		✓Psychological processes	✓Psychological processes	✓Complexity of task	✓Complexity of task
		✓Uses of ICT	✓Uses of ICT	Less elaborate	More elaborate
		✓Complexity of task	Less elaborate		
		More elaborate			

## Discussion

With regard to the first aim, it is worth noting that an interesting contribution of our study, along with the results obtained, is the design of the System of Categories for the Analysis of Beliefs about and Uses of ICT. We believe it is a useful, valuable tool, which will enable in-depth studies of relevant aspects of beliefs and uses of ICT, such as the learning outcomes it promotes or the type of information processing required. As described above, this system is an instrument for analysis which contributes different aspects not included in other available systems (Coll & Monereo, 2008; Mama & Hennessy, 2013; Prestridge, 2012; van Braaket al, 2004).

With regard to the following three aims of our study, the main purpose was to test whether there is consistency between teachers' educational beliefs about ICT and how they use them in the classroom. The results show that there is in fact a wide gap. While in most cases, beliefs involve elaborate conceptions of ICT as educational tools, the practices carried out reflect uses that are not highly transformative. Teachers think of ICT as instruments providing novel ways of relating to information, to others and to oneself. Access, speed, ability to modify and produce information, as well as the possibility of being in continuous contact with others, are characteristics that teachers recognise and value in ICT (Coll & Monereo, 2008). Nevertheless, the use they make of them does not indicate the same. ICT-mediated educational practice, as noted by Liu (2011), reflects teacher-centred activity, with few demands regarding processing information, and where the student, once again, fulfils a role as a passive consumer. This trend is similar to that found in other studies of teachers' conceptions of teaching and learning. Teachers still tend to focus more on the transmission of knowledge established by themselves than on construction of knowledge by students (López-Iñiguez, Pozo & de Dios, 2014; Olson & Bruner, 1996; Pozo *et al.*, 2006). However, due to the

sample size is very small, these results have to be interpreted carefully. Future researches should pay attention at this point.

With regard to the fifth aim, although it is true that there is usually a gap between beliefs and uses, we found that some specialist teachers and teachers of second and third stage of primary school proposed activities that made the most of ICT potential: interactivity, autonomy, reflection, managing uncertainty and metacognition were just some of the processes they put into motion in their classroom practice. These teachers are the example that shows that ICT can be extraordinarily powerful tools for promoting quality educational practices, where the aim is not merely to convey established knowledge, but rather to construct true knowledge. The new learning culture requires dialogue between teachers and students which transcends the limits of the classroom to include the new scenarios opened up by ICT. Specifically, information management through ICT should help promote three essential changes in ways of teaching and learning:

1. Change from realist epistemology based on one-directional conveyance of “true”, closed knowledge to joint management of knowledge, understood as collective negotiation of shared meanings.
2. Change from one-directional management of knowledge (monological) to multi-directional (dialogical), where the teacher is no longer a mere dispenser of established knowledge, but becomes a mediator in reflective dialogue.
3. Change from knowledge based on a single system of representation (written or oral language) to dynamic integration of multiple systems. This involves simultaneous management of multiple codes which make the teaching and learning processes more complex.

However, as noted throughout this paper, the mere introduction of technological devices into classrooms does not ensure change. We need to promote spaces for reflection in which to re-think the role that teachers and students play in society and education in the twenty-first century, where conceptions and beliefs about teaching and learning can be reformulated (Pozo et al., 2006). From a traditional conception based on the conveyance of established knowledge, the role of ICT is limited to a change in the support of teaching practice. However, based on conceptions where knowledge is not only an end in itself, but also a means for constructing a complex world view nurtured by contact with multiple voices and standpoints, ICT are exceptional tools for constructing a new learning culture. Future researches should analyse how all those processes are developed in specific contexts.

### **Acknowledgement**

The Spanish Ministry of Economy and Competitiveness has supported this research through the Project EDU2013-47593-C2-1-P.

## References

- Casas-Mas, A., Montero, I. & Pozo, J.I. (2015). El discurso sobre la práctica de un guitarrista de jazz semi-profesional: Estudio de caso de aprendizaje musical constructivo. *International Association for the Study of Popular Music Journal*, 5 (1) [http://www.iaspmjournal.net/index.php/IASPM\\_Journal/article/view/722](http://www.iaspmjournal.net/index.php/IASPM_Journal/article/view/722)  
doi: 10.5429/2079-3871(2015)v5i1.5es
- Coll, C. & Monereo, C. (Eds.). (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Collins, A. & Halverson, R. (2009). *Rethinking education in the age of technology. The digital revolution and schooling in America*. New York: Teachers College Press
- Cox, M., & Webb, M. (2004). *An investigation of the research evidence relating to ICT pedagogy*. London: Becta for DfES.
- Cuban, L., Kirpatrick, H. & Peck, C. (2001). High access and low use of technologies in high school classrooms: explaining an apparent paradox. *American Educational Research Journal* 38 (4), 813-834 doi: 10.3102/00028312038004813
- Drent, M. & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education*, 187-199  
doi:10.1016/j.compedu.2007.05.001
- Ertmer, P. (1999). Addressing first-and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development*, 47 (4), 47-61 doi: 10.1007/BF02299597
- Ertmer, P. (2005). Teacher pedagogical beliefs: the final frontier in our quest for technology integration? *Educational Research and Development*, 53 (4), 25-39  
doi: 10.1007/BF02504683
- Ertmer, P.A, Ottenbreit-Leftwich, A.T., Sadik, O., Sendurur, E. & Sendurur P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59, 423-435. doi:10.1016/j.compedu.2012.02.001
- Fisher, C., Dwyer, D.C., & Yocam, K. (Eds.). (1996). *Education and technology: Reflections on computing in classrooms*. San Francisco, Jossey-Bass.
- Hadjithoma, C. & Karagiorgi, Y (2009). The use of ICT in primary schools within emerging communities of implementation. *Computers & Education*, 52, 83-91  
doi:10.1016/j.compedu.2008.06.010
- Hennessy, S, Ruthven, K, & Brindley, S. (2005). Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution and change. *Journal of Curriculum Studies*, 37 (2), 155-192. doi:10.1080/0022027032000276961
- Hermans, R., van Braak, J. & van Keer, H. (2008). Development of the beliefs about primary education scale: distinguishing a developmental and transmissive dimension. *Teaching and Teacher Education*, 24, 127-139. doi:10.1016/j.tate.2006.11.007
- Hermans, R., Tondeur, J., van Braak, J. & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use computers. *Computers & Education*, 51, 1499-1509. doi:10.1016/j.compedu.2008.02.001
- Howard, S.K., Chan, A. & Caputi, P. (2014). More than beliefs: Subject areas and teachers' integration of laptops in secondary teaching. *British Journal of Educational Technology*, doi: 10.1111/bjet.12139

- Inan, F.A. & Lowther, D.L. (2010). Factors affecting technology integration in K-12 classrooms: a path model. *Educational Technology Research and Development*, 58 (2), 137-154. doi: 10.1007/s11423-009-9132-y
- Iniesta-Bonillo, M.A., Sánchez-Fernández, R. & Schlesinger, W. (2013). Investigating factors that influence on ICT usage in higher education: a descriptive analysis. *International Review on Public and Nonprofit Mark*, 10, 163-174  
doi:10.1007/s12208-013-0095-7
- Jamieson-Proctor, R. , Watson, G. , Finger, G. , Grimbeek, P. & Burnett, P.C. (2007) Measuring the Use of Information and Communication Technologies (ICTs) in the Classroom, *Computers in the Schools: Interdisciplinary Journal of Practice, Theory, and Applied Research*, 24:1-2, 167-184. doi: 10.1300/J025v24n01\_11
- Kerlinger, F. N., & Kaya, E. (1959a). The construction and factor analytic validation of scales to measure attitudes toward education. *Educational and Psychological Measurement*, 19, 13–29. <http://dx.doi.org/10.1177/001316445901900102>
- Kerlinger, F. N., & Kaya, E. (1959b). The predictive validity of scales constructed to measure attitudes toward education. *Educational and Psychological Measurement*, 19, 305–317. doi: 10.1177/001316445901900303
- Kim, C., Kim, M.K., Lee, C., Spector, J.M. & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76-85  
[doi:10.1016/j.tate.2012.08.005](https://doi.org/10.1016/j.tate.2012.08.005)
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 159-174. doi: 10.2307/2529310
- Liu, S. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers and Education*, 56, 1012-1022. doi:10.1016/j.compedu.2010.12.001
- López-Íñiguez, G. & Pozo, J.I. (2016) Analysis of constructive practice in instrumental music education: Case study with an expert cello teacher, *Teaching and Teacher Education*, 60, 97-107
- López-Íñiguez, G.; Pozo, J.I. & De Dios, M.J. (2014). The older, the wiser? Profiles of string instrument teachers with different experience according to their conceptions of teaching, learning and evaluation. *Psychology of Music*, 42(2), 157-176  
doi: 10.1177/0305735612463772
- Mama, M. & Hennessy, S. (2013). Developing a typology of teacher beliefs and practices concerning classroom use of ICT. *Computers & Education*, 68, 380-387.  
[doi:10.1016/j.compedu.2013.05.022](https://doi.org/10.1016/j.compedu.2013.05.022)
- Margaryan, A., Littlejohn, A. & Vojt, G. (2011). Are digital natives a myth or reality? University students' use of digital technologies. *Computers & Education*, 56, 429-440  
[doi:10.1016/j.compedu.2010.09.004](https://doi.org/10.1016/j.compedu.2010.09.004)
- Monereo, C. (2004). The virtual construction of the mind: the role of educational psychology. *Interactive Educational Multimedia*, 9, 32-47
- Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education*, 9 (3), 319-342. doi: 10.1080/14759390000200096
- Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19, 317–328. doi: 10.1080/0022027870190403



- Niederhauser, D.S. & Stoddart, T. (2001). Teacher's instructional perspectives and use of educational software. *Teaching and Teacher Education*, 17, 15-31  
[doi:10.1016/S0742-051X\(00\)00036-6](https://doi.org/10.1016/S0742-051X(00)00036-6)
- Olson, D. R., & Bruner, J. S. (1996). Folk psychology and folk pedagogy. In D. R. Olson & N. Torrance (Eds.), *Handbook of education and human development: New models of learning, teaching, and schooling* (pp. 9–27). Cambridge, MA: Blackwell.
- Pajares, M.F. (1992). Teacher beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62, 307-332 doi: 10.3102/00346543062003307
- Peek, S., Wouters, E., van Hoof, J. Luijkx, K., Boeijs, H. & Vrijhoef, H. (2014). Factors influencing acceptance of technology for aging in place: A systematic review. *International Journal of Medical Informatics*, 83, 235-248  
<http://dx.doi.org/doi:10.1016/j.ijmedinf.2014.01.004>
- Pelgrum, W.J. (2001). Obstacles to the integration of ICT in education: results from a worldwide educational assessment. *Computers & Education*, 37, 163-178  
[doi:10.1016/S0360-1315\(01\)00045-8](https://doi.org/10.1016/S0360-1315(01)00045-8)
- Pozo, J.I. (2008). *Aprendices y maestros. La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J.I. & Postigo, Y. (2000). *Los procedimientos como contenidos escolares*. Barcelona: Edebé
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., & de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.
- Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education* 58, 449-458 [doi:10.1016/j.compedu.2011.08.028](https://doi.org/10.1016/j.compedu.2011.08.028)
- Richardson, V. (2003). Pre-service teachers' beliefs. En J.Raths y A.C. McAninch (Eds.), *Teacher beliefs and classroom performance: The impact of teacher education* (pp. 1-22). Greenwich, CT: Information Age Publishing.
- Salomon, G., Perkins, D. & Globerson, T. (1991). Partners in cognition: extending human intelligences with intelligent technologies. *Educational Researcher*, 20 (3), 2-9  
doi: 10.3102/0013189X020003002
- Sang, G. Valcke, M. van Braak, J. & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: PredICTors of prospective teaching behaviours with educational technology. *Computers & Education*, 54, 103-112  
[doi:10.1016/j.compedu.2009.07.010](https://doi.org/10.1016/j.compedu.2009.07.010)
- Schön, D. (1987). *Educating the reflective practitioner*. San Francisco, CA: Jossey-Bass.
- Sigalés, C., Mominó, J.M<sup>a</sup>., Meneses, J. & Badia, A. (2008). *La integración de internet en la educación escolar española: situación actual y perspectivas de futuro*. Informe de investigación elaborado con la colaboración de la UOC y Fundación Telefónica.
- Silvernail, D., & Gritter, A. (2005). *Maine's middle school laptop program: Creating better writers*. Gorham, ME: Maine Education Policy Research Institute.
- Squires, D. & McDougall, L.S. (1994). *Choosing and Using Educational Software: a teacher's guide*. Londres: Falmer Press.
- Starkey, L. (2009). Teacher's pedagogical reasoning and action in the digital age. *Teachers and Teaching: theory and practice*, 16 (2), 233-244. doi: 10.1080/13540600903478433

- Tamim, R.M., Borokhovski, E., Abrami, P.C. & Schmid, R.F. (2011). What forty years of research says about the impact of technology on learning: a second-order meta-analysis and validation study, *Review of Educational Research*, 81 (1), 4-28  
doi: 10.3102/0034654310393361
- Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education*, 36(2), 163–174.  
doi: 10.1080/13598660801971641
- Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education*, 65, 12-33 doi:10.1016/j.compedu.2012.12.022
- Tondeur, J., van Braak, J. & Valcke, M. (2007). Towards a typology of computer use in primary education. *Journal of Computer Assisted Learning*, 23, 197-206
- Tondeur, J., Hermans, R., van Braak, J. & Valcke, M. (2008) Exploring the link between teachers' educational belief profiles and different types of computer use in the classroom. *Computers in Human Behaviour*, 24, 2541-2553  
doi: 10.1111/j.1365-2729.2006.00205.x
- Twining, P. (2002). Conceptualising computer use in education: introducing the Computer Practice Framework (CPF). *British Educational Research Journal*, 28 (1), 95-110  
doi: 10.1080/01411920120109775
- van Braak, J. (2001). Factors influencing the use of computer mediated communication by teachers in secondary schools. *Computers & Education*, 36, 41-57  
doi:10.1016/S0360-1315(00)00051-8
- van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of Psychology of Education*, 19, 407–422. doi: 10.1007/BF03173218
- Vekiri, I. (2010). Boys' and girls' ICT beliefs: Do teachers matter? *Computers and Education*, 55, 16-23 doi:10.1016/j.compedu.2009.11.013
- Vekiri, I. & Chronaki, A. (2008). Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers and Education*, 51, 1392-1404 doi:10.1016/j.compedu.2008.01.003
- Volman, M., van Eck, E., Heemskerk, I., & Kuiper, E. (2005). New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers & Education*, 45, 35–55. doi:10.1016/j.compedu.2004.03.001
- Zhao, Y., & Cziko, G. A. (2001). Teacher Adoption of Technology: A Perceptual Control Theory Perspective. *Journal of Technology and Teacher Education*, 9(1), 5-30.

**CAPÍTULO 7: ANÁLISIS DE LA PRÁCTICA E INTEGRACIÓN DE LAS TIC EN CONTEXTOS EDUCATIVOS (ESTUDIOS III Y IV)**

---

### ***Estudio III-Artículo III***

---

de Aldama, C., Pozo, J.I.<sup>1</sup> (in preparation). ICT as teaching and learning tools at university: A case study from a relational perspective

---

<sup>1</sup> This manuscript, still ongoing, has been partially written in collaboration with Dr. Ruben Vanderlinde and Dr. Jo Tondeur, from Ghent University, Belgium, during my stay in 2014.

## Abstract

Despite the many virtues ICT are assumed to have as educational instruments, transforming uses of ITCs are currently more an exception than the rule. This paper describes a case study through which we aim to unravel the underlying relationship among Learning Activity, Teacher and Students during ICT-mediated activities, in order to understand their integration process. We performed a micro-analysis of *Communication Cycles* during the practice of a teacher identified in a previous study (de Aldama and Pozo, in press), who had proved to be highly skilled in educational use of ICT. Our findings show that the nature and aims of the proposed activities are the first step in a more complex mechanism which directly affects students' requests and the pedagogical assistance provided by the teacher. Future lines of work are discussed within a wider theoretical context.

## Introduction

The number of papers analyzing ICT integration processes in educational settings has increased in recent years (Bauer & Kenton, 2005, Newhouse & Clarkson, 2008; Davies & West, 2014). Although some of these papers report that teachers are beginning to integrate ICT into their classrooms (Tondeur, Cooper & Newhouse, 2010), it is not yet a general rule (Gray et al. 2010). The European Survey of Schools: ICT and Education (ESSIE) conducted by the European Commission (2013) shows that there is a positive tendency compared to the previous report (Balanskat, Blamire & Kefala, 2006); nevertheless, ICT integration is still far from meeting expectations. The original document says:

*The low use of digital resources and tools is a concern. [...], only 30% of students use them once a week or almost every day, but more than 50% of students at all grades never or almost never use such resources. (p.18).*

As noted by Tondeur, Kershaw, Vanderlinde and van Braak (2013), ICT integration in educational settings should be understood as a complex system in which multiple factors have joint influence. We can thus identify different levels of analysis, ranging from a macro scale (such as designing and implementing educational policies [Kozma, 2003]), to an organizational level (where the actions and leadership of the team of directors are crucial [Fernández-Enguita, 2013]), to a more micro dimension (focusing on teaching and learning processes in the classroom [Coll & Monereo, 2008]). Due to the complex, dynamic nature of teaching and learning processes, the micro dimension is key to understanding the process of effective ICT integration in daily practice (Davies and West, 2014). Coll and Monereo (2008) claim that any action performed in the classroom can be understood as the relationship and interaction among teacher, students and learning content or activities, in what they call an "interactive triangle". They claim that effectively integrated ICT would mediate inter- and intra-psychological processes occurring in any teaching-learning process, contributing to shape the joint activity context.

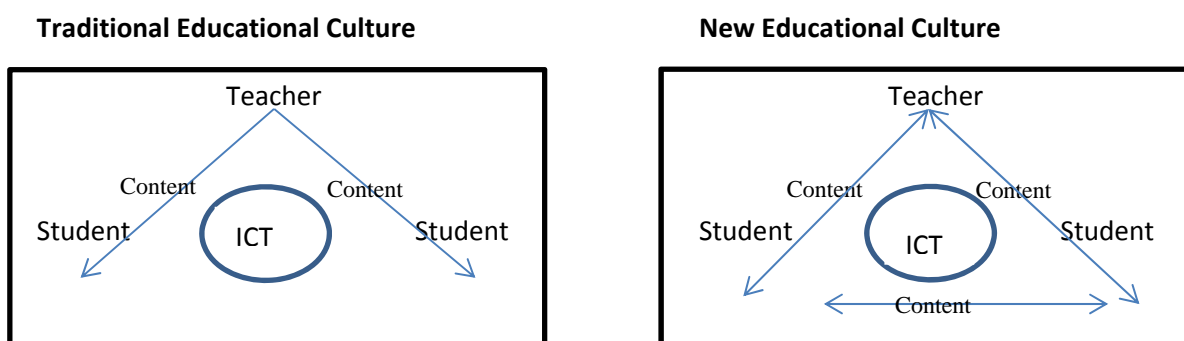
The aim of this paper is to analyse the relationship among the parts of the interactive triangle in an ICT-mediated learning setting, through a case study.

## Background

*Teacher, students and learning content: an interactive ICT-mediated triangle in the new learning culture.*

For several years now, as a result of the dramatic social changes due to the massive expansion of ICT in our daily lives, people often speak of a change in educational paradigm, and of a new learning culture (Pérez-Gómez, 2012; Pozo et al., 2006; Starkey, 2012). Responding to the demands of an increasingly complex economic, political and social setting involves rethinking the ultimate purpose of our educational institutions and thus the roles played by the different agents who take part in them. Up to the present, the *Teacher* served as a link between established knowledge and the student. However, in this new scenario, the Teacher is more of a guide who accompanies the student in his/her learning process, providing tools that will enable him/her to manage highly complex and uncertain settings emotionally and cognitively. In the traditional educational culture, mainly based on associative processes and well delimited and defined knowledge (Pérez-Gómez, 2012), the teacher acts as a provider of information and an example to follow (Claxton, 1990; Olson & Bruner, 1996; Pozo, 2008). The learner is merely an observer of his/her own process, a consumer of information who will be successful to the extent in which he/she is capable of faithfully replicating the model proposed by the teacher (Llorente, Barroso & Cabero, 2015).

In contrast, in the new educational tradition, which requires mainly constructive processes (Bransford, Brown & Cooking, 2000; Pozo, 2008; Sawyer, 2006), the *Teacher* must design learning settings based on complex, open, dynamic *Contents* (Pérez-Gómez, 2012), which are spaces where the *Teacher* guides the *Student* and allows him/her to take control of his/her own learning, developing his/her capacity to manage highly uncertain situations both emotionally and cognitively (Llorente, Barroso & Cabero, 2015). The following graph represents the relationship among the parts of the interactive triangle according to educational culture.



*Fig.7.1.1. Relationship among the parts of the interactive triangle according to educational culture.*

*Learning and processing levels*

The now renowned work by Bloom (1956), subsequently revised by Krathwohl (2002), developed a taxonomy of educational aims intended to encompass all the learning outcomes that students are expected to acquire as a result of their activity in instructional settings. In its revised version, learning outcomes are classified in two dimensions: type of knowledge and underlying cognitive processes. According to the nature of the learning in question, knowledge may be factual, conceptual, procedural or metacognitive, while, according to its level of complexity, the underlying cognitive processes are remembering, understanding, applying, analyzing, evaluating and creating. These categories are summarised in Table 7.1.1.

**Table 7.1.1.** *Adapted from Bloom's Revised Taxonomy (Krathwohl, 2002)*

LEARNING OUTCOMES	TYPE OF KNOWLEDGE	<i>Factual:</i> Basic elements of a discipline. Data.
		<i>Conceptual:</i> Relationships established among basic elements.
		<i>Procedural:</i> Methods, techniques and skills involved in how to resolve a given problem.
		<i>Metacognitive:</i> Self-knowledge and awareness of one's own cognitive processes involved in the task.
	COGNITIVE PROCESSES	<i>Remembering:</i> Retrieving relevant information from memory in the long term.
		<i>Understanding:</i> Extracting the meaning of the instructional message, whether oral, written or graphic.
		<i>Applying:</i> Using a procedure in a concrete situation.
		<i>Analysing:</i> Breaking down a certain phenomenon into its constituent parts and detecting the relationship among them.
		<i>Evaluating:</i> Making judgments based on criteria or standards.
		<i>Creating:</i> Developing an original production.

Using an approach which is also cognitive, but adds a dialogical dimension, Pozo and Postigo (2000) distinguish information processing levels when determining the procedures involved in any teaching and learning activity. They distinguish among information acquisition, interpretation, analysis, comprehension and organization, and lastly, communication. These dimensions are summarised below.

**Table 7.1.2.** *Information Processing. Adapted from Pozo and Postigo (2000).*

<b>Information Processing</b>				
This category evaluates the cognitive demand of the activities proposed, i.e. what kind of mental operations and cognitive resources students must put in motion to resolve the activity satisfactorily.				
<b>B.1 Acquisition</b>	<b>B.2 Interpretation</b>	<b>B.3 Analysis</b>	<b>B.4 Comprehension and Organisation</b>	<b>B.5 Communication</b>
Acquiring new information. Procedures of finding, gathering, selecting and maintaining information.	Transcribing information to a new code or comparing it to a model in order to be able to work with it.	Drawing conclusions. Involves inferences and deductive-inductive procedures.	Simultaneous relationship of present and non-present information. Specific procedures for organization (outlines, conceptual maps, summaries, etc.).	Conveying, exchanging and contrasting information among students.

Both classifications share the idea that there are different degrees of cognitive complexity regarding the information processing underlying different learning which can take place in instructional spaces. For instance, memorizing a list of the rivers in Europe would involve more superficial and de-contextualised information processing than would, for example, endeavouring to explain the causes of global warming.

Increasingly complex social, political and economic conditions more than ever call for developing critical, reflexive thinking. The OECD DeSeCo Project –*Definition and Selection of Competencies*– (2005) proposes *reflectiveness* as the cornerstone upon which to develop the rest of the skills anyone needs in the 21<sup>st</sup> century. Due the potential of ICT as *psychological instruments* in a Vygotskian sense (Coll & Monereo, 2008), they are considered preferential tools for developing that reflectiveness. Their quality as semiotic instruments enabling people to relate to information and knowledge in a way unknown to date makes them preferred devices for mediating the cognitive processes underlying teaching and learning activities.

Notwithstanding the above, many studies highlight the lack of real, transforming impact at our schools as a result of introducing ICT into the classrooms. One of the outstanding results in the *European Survey of Schools: ICT and Education* (European Schoolnet, 2013a) is that teachers often use ICT to prepare their lessons, but rarely use them in the classroom with learning aims. Similar results have been found in other parts of the world. The report on educational use of ICT by teachers at public schools in USA (Gray, Thomas & Lewis, 2009) states that although ICT are available daily in the classroom to 99% of these teachers, only 40% report using them frequently. Findings on the educational impact of ICT in Asia are even more alarming. In addition to the enormous differences with relation to technological infrastructure between regions, very little empirical evidence was found (UNESCO, 2014).

Studies with a more qualitative approach report similar findings. A recent study by Prestridge (2012) analyses the relationship between teachers' pedagogical beliefs and educational use of ITCs in the classroom. The findings showed that most teachers conducted activities in which using ICT was Foundational, i.e., practices involving a very early stage of ICT integration in the classroom, while there was hardly any planning or deep reflection on its



pedagogical implications. Similarly, de Aldama and Pozo (in press) designed and validated a categorical analysis system of educational beliefs and uses of ICT that would enable the relationship between them to be studied. The findings showed that the activities conducted by the teachers involved replicating traditional practices and merely changing the format.

There are similar examples in higher education, where the fact that students are more skilled than those at lower levels suggests that there may be more complex uses of ICT from the standpoint of information processing. However, reality is more complex. A meta-analysis by Schmid et al. (2014) on the effects of using technology in higher education showed that practices varied widely, and found both positive and negative examples from the standpoint of learning quality. They conclude that learning improves when the student participates in significant activities mediated by ICT as instruments of cognitive support, i.e., activities in which ICT are used such that they support students' creative participation and critical analysis of information, not merely as tools for conveying information. The basic difference may lie in that the former activities (using ICT as instruments of cognitive support) focused on epistemic goals (Kirsh and Maglio, 1994; Pozo, 2008) and were based on the understanding of what we do (Piaget, 1974), while the latter tasks (using ICT as tools for conveying information) focused on pragmatic goals (Kirsh y Maglio, 1994; Pozo, 2008) and were based on achieving success or correct execution (Piaget, 1994). The authors point out that we do not yet have in-depth knowledge about how to design these instruments for cognitive support or how to integrate them efficaciously in instructional contexts.

Thus, the aim of this study is to contribute empirical evidence regarding the relationship among learning activity, teacher and students in a complex ICT-mediated setting, by analyzing a case study. This knowledge will provide clues on to how to narrow the gap between the educational potential of technology and its current questionable transforming effect.

## **Method**

### *Participants*

The sample consists of one male teacher (whom we will call Jorge), aged 30 years at the time we collected the information, and his 46 students (42 male and 4 female,  $\bar{X} = 22.4$  years and S.D = 2.7) in the subject "Sport Activities in Nature" within the degree course Physical Activity and Sports Sciences (*Ciencias de la Actividad Física y el Deporte, CCAFYD*). We selected this teacher to analyse in-depth because in a previous study (de Aldama y Pozo, in press) he demonstrated the greatest skill in educational use of ICT.

Jorge has a Licentiate degree and a Master's degree in CCAFYD and is currently writing a PhD thesis on the same subject. He is co-founder of a democratic, collaborative digital environment in Spain for students who cannot attend face-to-face lessons. He is also in charge of a blog on educational innovation and cooperates in many projects that aim to change and improve Education.

His professional experience includes over 10 years' teaching at all educational levels, ranging from child education to university level. In all of these he has endeavoured to integrate ICT as tools to improve teaching and learning processes.

### *Procedure*

We agreed with Jorge upon a Didactic Unit called "Risk Management in Nature" from the curriculum of the subject he was teaching. The unit comprised two 3-hour face-to-face sessions over two weeks.

Students worked in small groups (3-5 students) with one/several computers (depending on availability) to resolve activities chosen freely from the Digital Learning Environment (DLE) which Jorge had designed previously (<https://gestiondelriesgoenlanaturaleza.wordpress.com/>). The activities they could choose from were classified into three different groups, according to the contents and procedures required. Specific Content Activities (SCA or Green activities in the DLE) required searching for information related to a concept or procedure (see examples in Table 3). Specific and Procedural Content Activities (SPCA or Purple Activities in the DLE) were relatively similar to SCA, but additionally required designing or developing a material or product (see examples in Table 3), i.e. in addition to searching for information, they called for management and proficiency in some kind of software, preferably text or audiovisual processors. Stance and Argument Activities (SAA or Blue Activities in the DLE) differed qualitatively from the other two, requiring taking a stance with regard to a concrete subject, by using different arguments which were to be contrasted through different information sources (see examples in Table 3). Using the terminology published by Pozo and Postigo (2000) to analyse how information was processed throughout the instructional activity, we could say that SCA and SPCA tended to favour processes for acquiring and interpreting information and procedures, while SAA involved more complex processes such as analysis and comprehension of information. (see Table 7.1.3)

Students could choose the activities they wanted to do freely, but the final evaluation would differ according to their decisions. Initially, all students would be evaluated during the second session with a one-and-a-half hour written test in which they would have to answer 15 Specific Content questions. However, for each SPCA or SAA resolved during the two sessions, one question would be eliminated from the written test. Thus, a group that had answered 3 SPCA and 2 SAA over the two sessions would only have to answer 10 questions in the final exam.

Both sessions were recorded with two video recorders and a microphone that Jorge was asked to wear at all times to record all interaction with his students. Finally, we conducted two interviews with Jorge: a general interview to discuss educational conceptions and a more specific interview about the aims of the sessions.

**Table 7.1.3.** *Examples of activities in DLE*

Activity Type	Requirement	Examples
Green Activities / Specific Content Activities (SCA)	Search for factual / conceptual information	<ol style="list-style-type: none"> <li>1. What is the relationship between risk and hazard?</li> <li>2. What types of accidents are there?</li> </ol>
Purple Activities/ Specific and Procedural Content Activities (SPCA)	Search for factual/ conceptual information + preparing a product (written/audiovisual document)	<ol style="list-style-type: none"> <li>1. The terms hazard and risk are often confused. Knowledge of both can help us prepare a good accident prevention plan. <b>Create an infographic explaining the difference between the two concepts.</b></li> <li>2. La Pedriza is in the new National Park “Parque Nacional de la Sierra de Guadarrama” but at present, and until the new regulations are published, it is regulated by the Regulatory Plan for “Parque Regional de la Cuenca Alta del Manzanares”. <b>Analyse how sport activity in nature is regulated in the plan and explain it in a video. Upload the video to Youtube and share the link.</b></li> </ol>
Blue Activities/ Stance and Argument Activities (SAA)	Search for information, contrast sources, critical argumentative analysis	<ol style="list-style-type: none"> <li>1. It is not mandatory for multi-adventure companies to provide accident insurance for their clients. In case of accident, a client would cover his own expenses if the company did not have insurance. <b>Why do you think this rule exists? Write arguments for and against the non-compulsory nature of purchasing accident insurance.</b></li> <li>2. You belong to a popular jury with regard to the ruling that appears below. <b>Issue a verdict (it may differ from the real ruling) and justify it. If your verdict is the same, you must support the justification with other sources, not only your opinion. (See verdict on the web.)</b></li> </ol>

### Analysis

*Communication Cycles* are the basic communication unit in any dialogical process between teacher and student (Erickson, 1982; Sánchez et al., 2008; Stodolsky, 1988). Each Communication Cycle comprises the verbal exchanges needed to reach an agreement with regard to a given matter. The following exchange is an example of a *Communication Cycle*:

Student: For type of accident, does it mean accidents in nature?

Jorge: This is the same question that Jose asked me. Have you searched?

S: We put “types of accidents” and we got home accidents, falls...

J: Types of accidents? Let me see...let me, let me see how the question is asked on the blog.

S: What types of accidents are there...

J: In nature, in sports activities in nature, the question is incomplete. Otherwise, it's never-ending, of course (Cycle 3)

There are different kinds of *Communication Cycles*, depending on the structure of the interaction (who begins and ends the Cycle), who participates (Teacher-Student; Teacher-Students; Student-Student...), content of the interaction, etc.

We used *Communication Cycles* as analysis units in our study, with special attention to those referring to a specific learning content (there are many other types of Communication Cycles in each session, such as those referring to classroom management and administration, e.g. Student: "Sir, may I close the window?"; Teacher: "Yes, of course.")

Nearly all the *Communication Cycles* referring to a learning content in our paper are similar from the standpoint of structure because they respond how the classroom activity is organised. The following outline describes this organization.

### Classroom Activity Structure

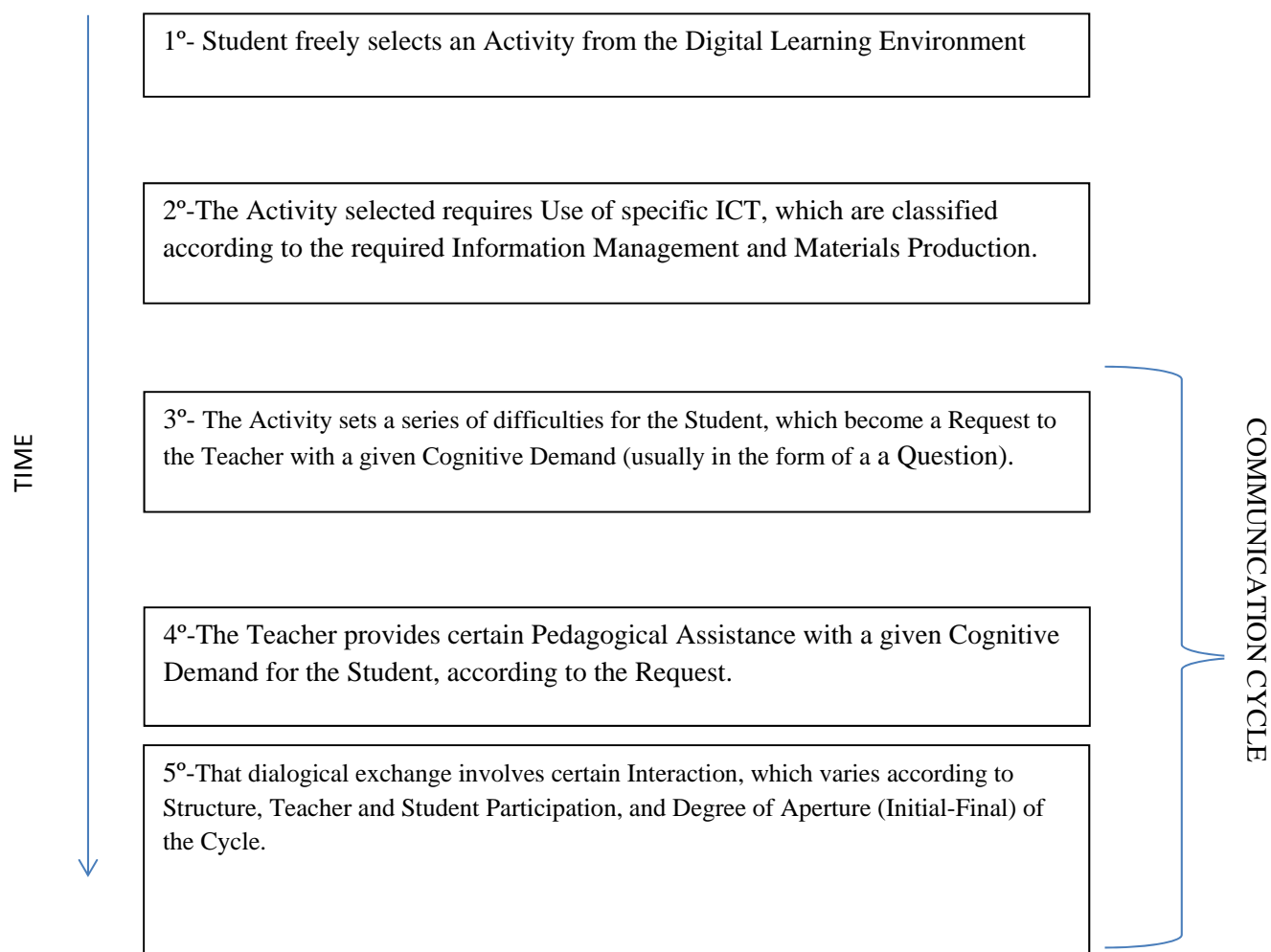


Fig.7.1.2. Structure of activity in classroom

We analysed each Communication Cycle referring to a learning content within the context of its production by designing categories that were defined through a deductive-inductive process and agreed upon by the different members of the research team. The following is a summary of those categories:

**Table 7.1.4.** *Description of categories of analysis*

Cycle		Cycle number
Description		Communicative Exchange corresponding to this Cycle.
Activity		Activity in the Digital Learning Environment upon which the Cycle develops.
Use of ICT		Use of the ICT required for the Activity chosen by Student.
Student	Request	Student's request to Teacher after attempting to resolve the chosen Activity.
	Cognitive Demand	Degree of complexity of Student's request.
Teacher	Pedagogical Assistance	Pedagogical Assistance provided by Teacher to Student following Request
	Cognitive Demand	Degree of complexity of Pedagogical Assistance provided by Teacher to Student following Request.
Interaction	Participation Structure	<i>Short Cycle:</i> 2-3 exchanges (or more exchanges not longer than one phrase each.) <i>Long Cycle:</i> More than 3 exchanges (or less than 3, but with long interventions.)
	Participants and Participation Level	Degree to which Teacher and Student participate in Planning and Supervising the Activity. Responsibility may be individual or shared.
	Aperture (Initial-Final)	Degree to which Student's initial Request is limited and degree to which the problem is limited following Teacher's Pedagogical Assistance. May be <i>Closed</i> or <i>Open</i> .

The following example shows how a *Communication Cycle* is analysed:

**Table 7.1.5.** *Example of analysis of a Communication Cycle*

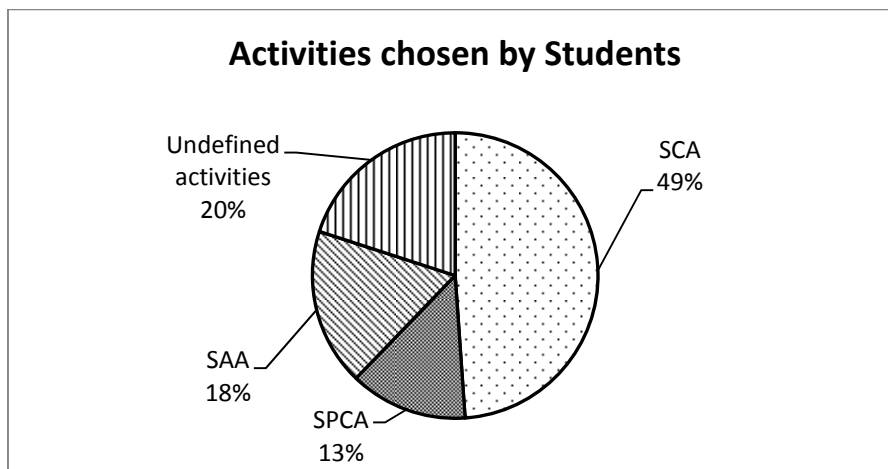
Cycle	Description	Activity	Use of ICT	Student		Teacher		Interaction		
				Request	Cognitive Demand	Pedagogical Assistance	Cognitive Demand	Participation Structure	Participants and Participation Level	Aperture (Initial-Final)
3	<p>Student: For type of accident, does it mean accidents in nature?</p> <p>Jorge: This is the same question that Jose asked me. Have you searched?</p> <p>S: We put "types of accidents" and we got home accidents, falls...</p> <p>J: Types of accidents? Let me see...let me, let me see how the question is asked on the blog.</p> <p>S: What types of accidents are there...</p> <p>J: In nature, in sports activities in nature, the question is incomplete. Otherwise, it's never-ending, of course</p>	SCA What types of accidents are there?	Factual search	Ask: Factual Confirmation	Acquisition of Information	Ask Factual Inform Factual	Information Acquisition	Short Cycle	T-S	Closed-Closed

## Results

We identified 131 Communication Cycles altogether, of which 45 were about a specific learning content. Below is the distribution of the Activities selected by Students corresponding to those 45 Cycles.

### *Activities chosen by students*

The Figure 7.1.3 shows that Students chose a higher proportion of SCA, i.e. the more limited activities which are simpler to resolve from the standpoint of the ICT Uses required. The next section analyses ICT Uses required by each activity.



*Fig.7.1.3. Activities chosen by students*

### *ICT Uses required by Activities according to Information Management.*

Pearson's Chi-squared test reveals significant differences regarding the Information Management required for activities ( $\chi^2 (8, 49) = 46, 401; p < 0.01$ ). SCAs are mainly based on Factual Search, i.e. search for concrete data or information; SPCAs require a greater measure of information involving relating concepts, and SAAs go a step further because in addition to requiring search for information in which conceptual relations need to be established, they call for critical analysis and contrasting the reliability of the sources

The next section analyses how the ICT Uses differ from the standpoint of the Materials Production they require.

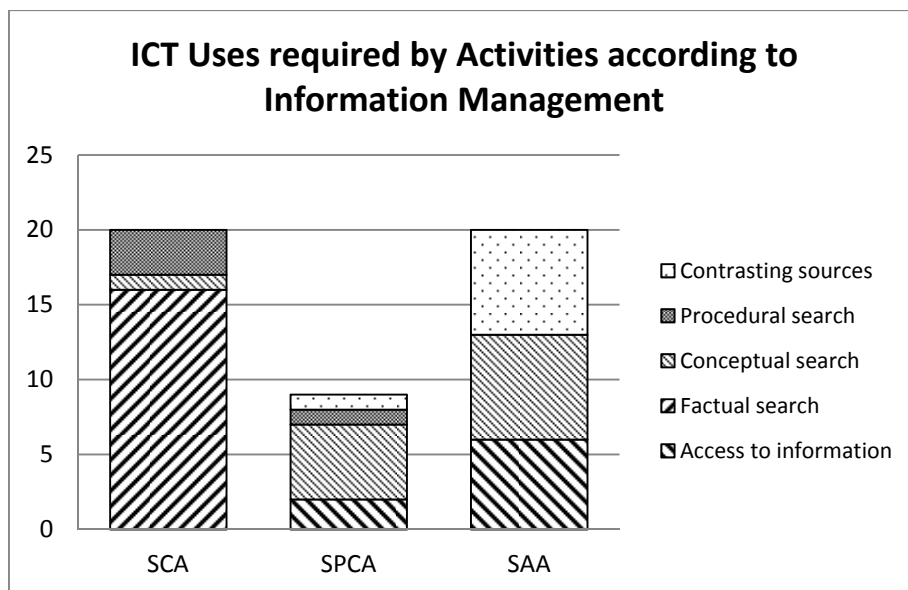


Fig 7.1.4. ICT Uses required by Activities according to Information Management

*ICT uses required by the Activities according to Materials Production.*

Pearson's Chi-squared test reveals significant differences regarding the Materials Production required by activities ( $\chi^2 (4, 46) = 11, 545; p = 0.021$ ). SCAs do not require any material to be produced, i.e. they simply require ICT to search for information. The other two types of activity differ mainly in that SPCAs require less reflective activities (such as Publishing or Presenting Information), whereas SAAs require greater development and treatment of the Information (such as Arguing or Transferring Knowledge).

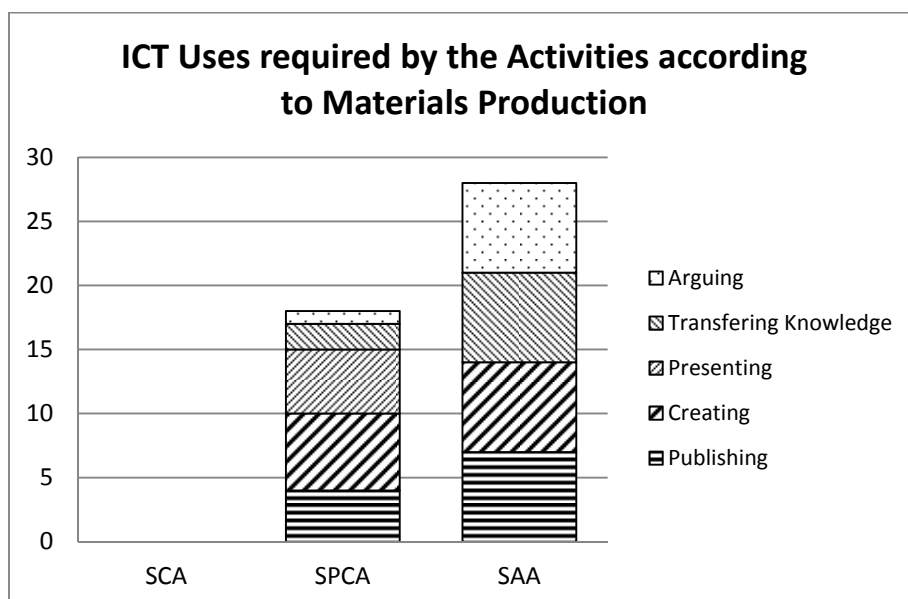


Fig.7.1.5. ICT Uses required by the Activities according to Materials Production



The next section analyses how the activities chosen by Students relate to the type of questions or problems presented.

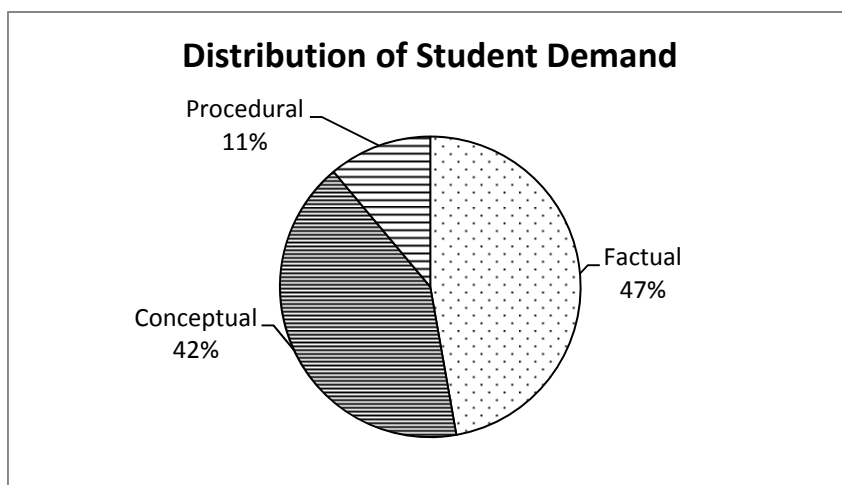
*Distribution of Student Demand according to Activities chosen.*

Pearson's Chi-squared test reveals no significant difference regarding type of questions asked according to activities chosen ( $\chi^2 (4, 36) = 3,351; p > 0,05$ ). Although SAAs seem to be more associated to Conceptual Demands, i.e., questions that involve relating and critical analysis of information from different sources, students usually ask factual type questions. In other words, students do not seem to be concerned as much about understanding the concept or procedure for resolving a task, as about acquiring the data or information needed to answer the question.

For example:

Student: "Jorge, where can we find the information about the regulatory plan for the park, I mean, where does that come from, where can we find it...?" (Cycle 8)

where students do not seem to be interested in how to find the information (procedure), but rather in where to find it (factual data).



*Fig. 7.1.6. Distribution of Student Demand*

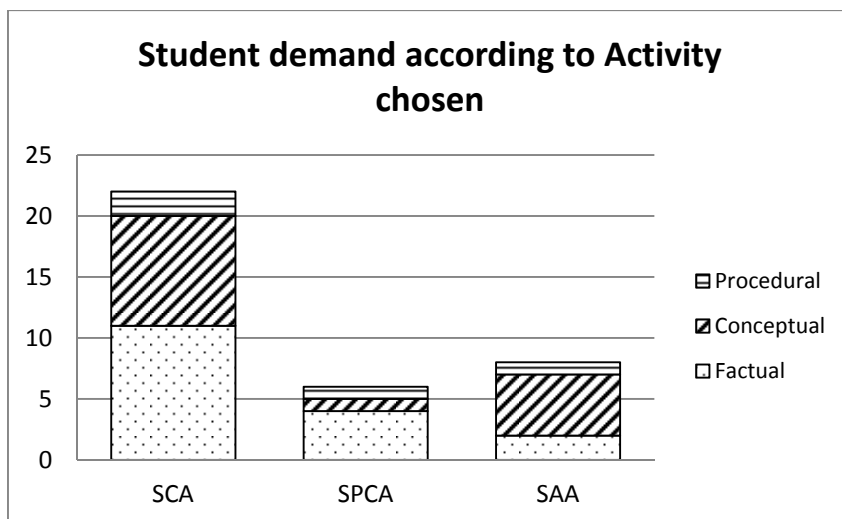


Fig 7.1.7. Student demand according to Activity chosen

The next section analyses how the complexity of the type of questions asked by Students relates to the activities they choose.

#### *Cognitive Demand of Student Request according to Activities Chosen*

Pearson's Chi-squared test shows significant differences regarding the Cognitive Demand of the questions asked by students according to the activities chosen ( $\chi^2 (8, 38) = 28, 267$ ;  $p < 0.01$ ). SCAs and SPCAs are usually associated to questions that mainly involve Acquisition of Information or Procedure, whereas SAAs are more often related to questions involving more varied and complex questions, such as Analysis of Information.

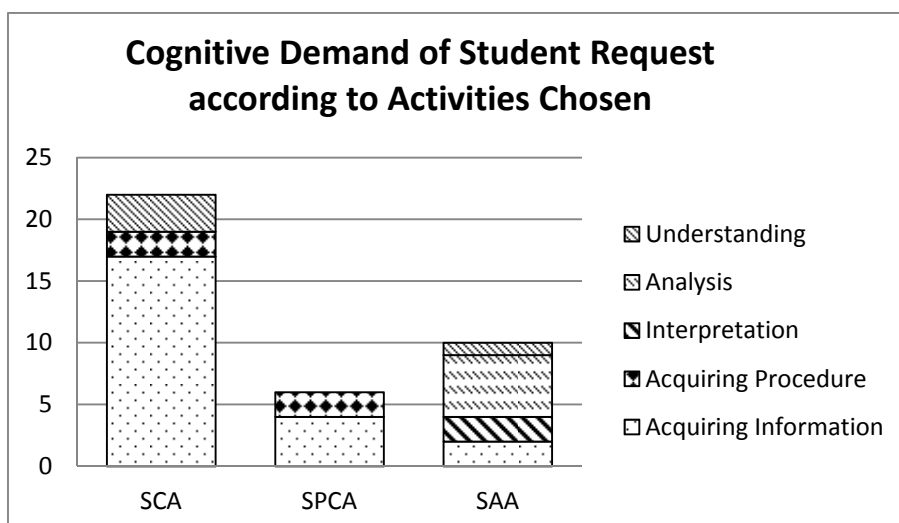


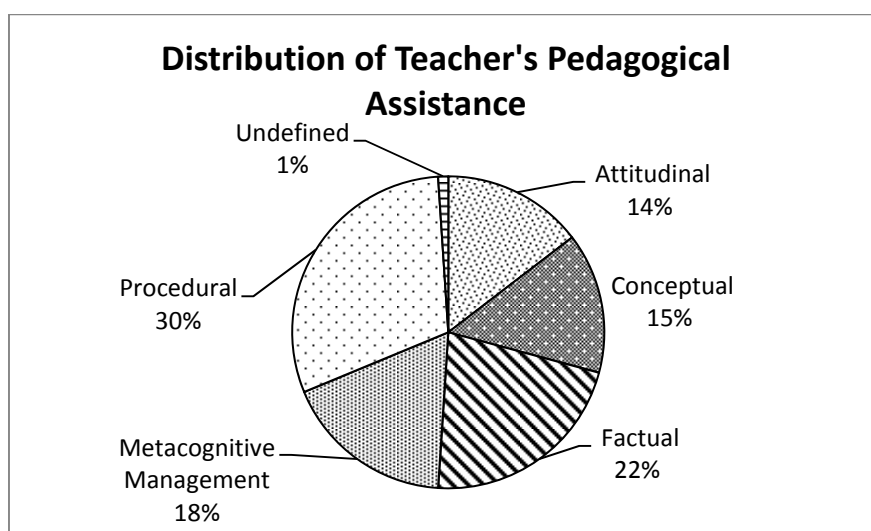
Fig.7.1.8. Cognitive Demand of Student Request according to Activities Chosen

The next section discusses how the Student Request relates to the Pedagogical Assistance provided by the Teacher.

### *Teacher's Pedagogical Assistance according to Student Request*

Pearson's Chi-squared test shows no significant difference in Pedagogical Assistance offered by the Teacher to his Students according to their request ( $\chi^2 (10, 95) = 14, 107; p > 0,05$ ).

The type of Assistance Jorge offers is highly variable, although mainly associated to Procedures (30%), specifically, *information search*. This learning is often accompanied by Metacognitive Management (18%), i.e., conscious, intentional reflection on what is being learned and how it is being learned. There is also a high percentage of Factual content (22%), associated to the more closed cycles where Jorge simply informs. It is very interesting to contrast how **whereas students focus more on data and concepts** (see Figures 7.1.6 and 7.1.7), **Jorge is more interested in the procedure and the proper way of acquiring it** (see Figure 7.1.9).



*Fig 7.1.9. Distribution of Teacher's Pedagogical Assistance*

The following section analyses how Teacher's Pedagogical Assistance relates to Activities chosen by Students.

### *Teacher's Pedagogical Assistance according to Activity chosen by Student.*

Pearson's Chi-squared test shows significant differences regarding Teacher's Pedagogical Assistance to Students according to Activity chosen ( $\chi^2 (8, 84) = 19, 540; p < 0,05$ ). Although as mentioned above, Jorge mainly provides procedural and factual assistance, the pattern changes when the student asks a question about an SAA, in which case Jorge focuses more on managing metacognitive processes involved in the task. This is consistent, because since SAAs call for contrasting sources and arguing critically, they raise awareness and reflection on different opinions related to the issue.

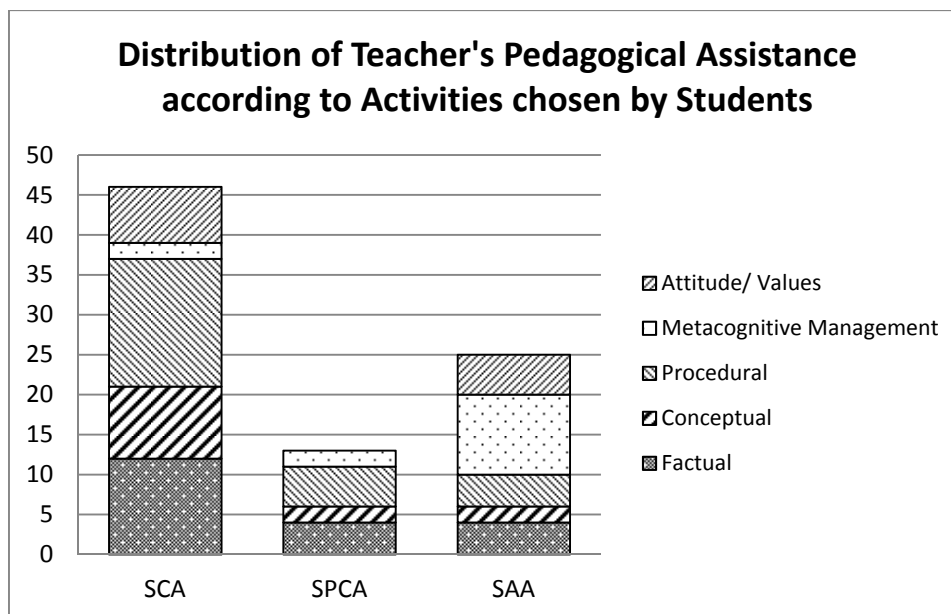


Fig.7.1.10. Distribution of Teacher's Pedagogical Assistance according to Activities chosen by Students

The following section analyses the relationship between the Cognitive Demand of Pedagogical Assistance and Activities chosen by Students.

#### *Cognitive Demand of Teacher's Pedagogical Assistance according to Activities chosen by Students*

Pearson's Chi-squared test shows significant differences in the Cognitive Demand of Teacher's Pedagogical Assistance to Students according to the activity chosen ( $\chi^2 (12, 47) = 30,830$ ;  $p < 0,01$ ). When Students choose SCA or SPCA, the Cognitive Demand of Teacher's Pedagogical Assistance is usually limited to Information or Procedure Acquisition processes. However, when students select SAA, Assistance tends to be more varied and complex, mainly based on processes of Analysing and Communicating Information. In other words, although as mentioned above, Jorge endeavours to redefine the student's request to make it more complex, the very nature of the Activities makes the Assistance provided different according to the case. This is illustrated by the two following examples:

Student: "What do you mean by 'dimensions of risk'? Is there a definition?"

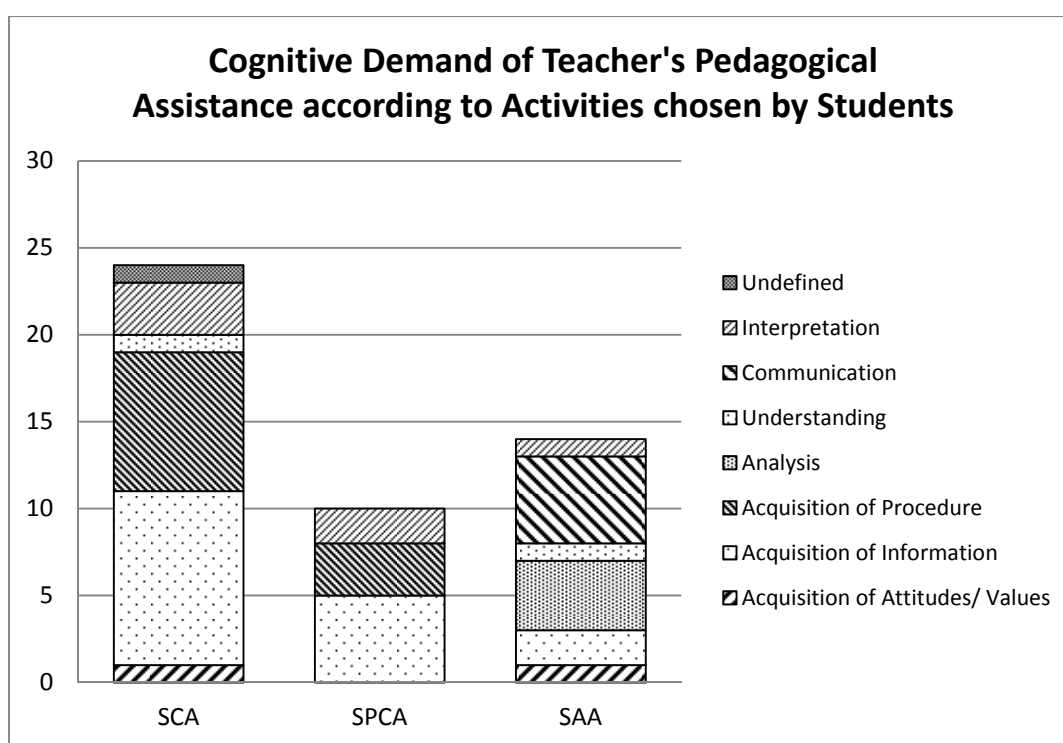
Jorge: "They are parameters, dimensions or parameters" (Cycle 31, about the SCA: "What are the different dimensions of risk?")

The above example shows a student requesting clarification of the task, which involves acquiring new information. The Pedagogical Assistance offered by Jorge is limited here to resolving the question by providing the information needed to continue with the task, demanding only a process of acquisition. The following is another excerpt from a Communication Cycle which arose in the context of a group of students trying to resolve an SAA:

Student: “[...] Is this page reliable?”; Jorge: [...] It depends on who wrote it; S: “And how do you know who wrote it?”; J: “I trust it if after reading it I find it is well written”; S: “Well documented?”; J: “Well documented. Have you looked for something similar on other sites?”; S: “Yes”; J: “And is it consistent?”; S: “It says something similar”; J: “So you tell me, is it reliable?”; S: “I would trust it; the thing is, as I don’t know if the site...”J: “It’s that the site doesn’t always, I mean doesn’t condition whether or not something is reliable. It’s what is written, how it is written, who wrote it”; S: “Thanks” (Cycle 33, referring to an SAA).

The above example shows that Jorge’s Pedagogical Assistance turns a student’s “yes-no” question (Is this page reliable?) into the starting point for joint reflection on criteria for the reliability of information sources. The interesting point in this teacher intervention is that beginning from the student’s question, the request is reformulated through interaction into a more complex and elaborate request involving deeper processing of information.

As shown by the two examples above, interaction among the different parts of the interactive triangle may vary widely. The following section analyses how they relate in further detail.



*Fig.7.1.11. Cognitive Demand of Teacher's Pedagogical Assistance according to Activities chosen by Students*

#### *Interaction: Structure of Participation*

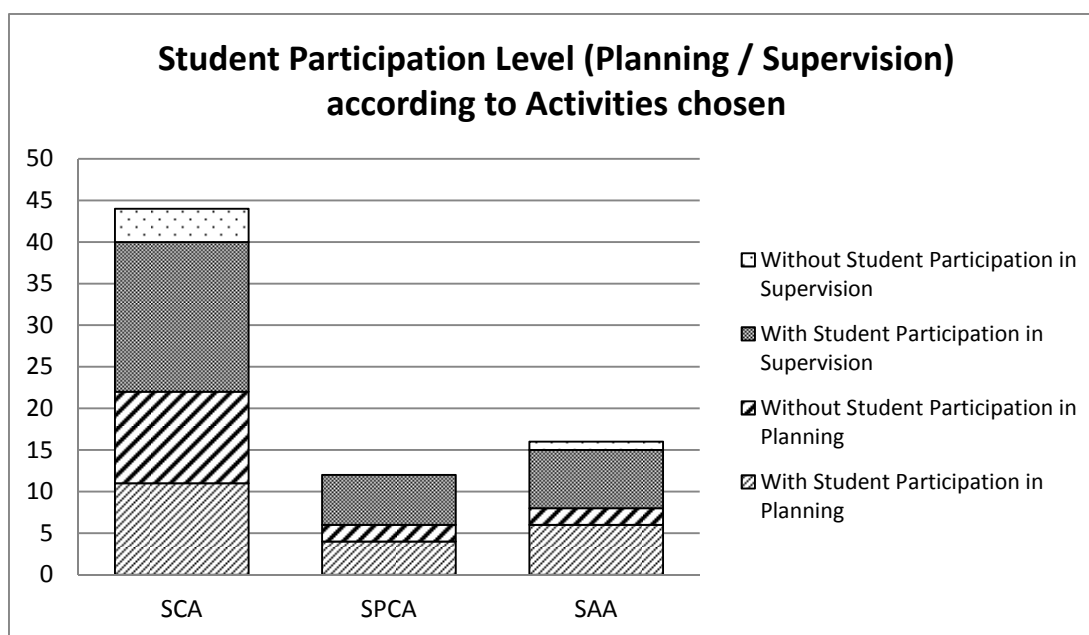
Pearson’s Chi-squared test reveals no significant difference in Participation Structure according to Activities chosen by Students ( $\chi^2 (2, 34) = 4,409; p > 0,05$ ). This means that

regardless of the activity chosen, most Communication Cycles are similar in structure. In this case, 2 out of every 3 cycles are long. Teacher-Student Participation Structure consists mainly of Communication Cycles where both sides participate actively. It is interesting to note that even though 47% of student requests are factual (see Figure 7), i.e., matters that could be resolved briefly, most of the Communication Cycles are long. This may be due to the Teacher's deliberate effort to give his Students a voice.

The next section analyses the extent to which the Teacher takes into account this voice for task Planning and Supervision, i.e., the extent to which Jorge allows his students to take control of their own learning.

#### *Interaction: Level of Participation*

Pearson's Chi-squared test reveals no significant difference in Student Participation Level according to activities chosen ( $\chi^2 (6, 72) = 3,034; p = 0.805$ ). The graph shows that Students participate to a great extent in both Planning and Supervision for resolving the Activity, regardless of the activity. This means that Jorge not only encourages long Communication Cycles, but also allows Students to be participants in and responsible for their own learning process while resolving the task, during both the Planning and the Supervision phases.

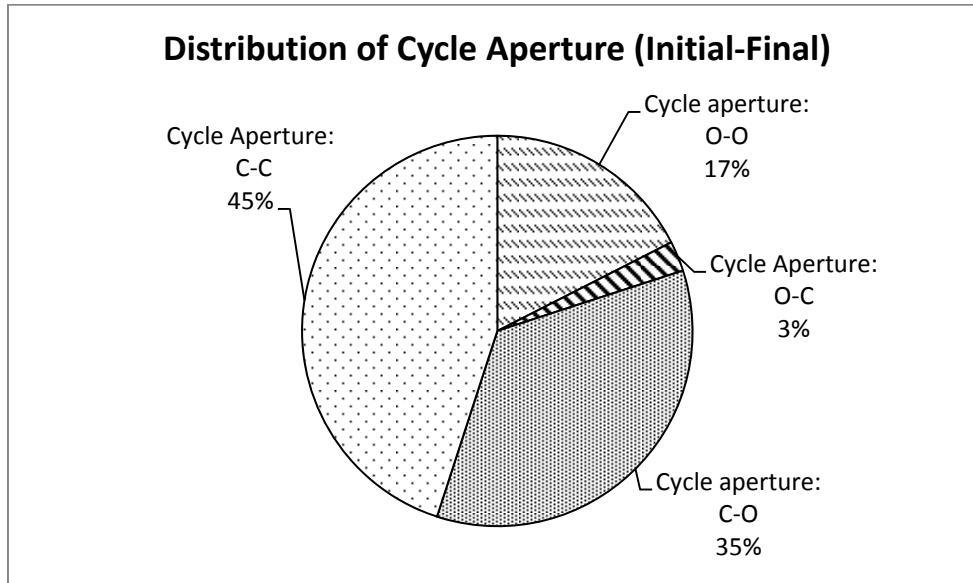


*Fig.7.1.12. Student Participation Level (Planning / Supervision) according to Activities chosen*

Below, we analyse whether that interaction, where Students have a high level of control, gives rise to a transformation in the way the problem upon which the Communication Cycle hinges is limited.

*Interaction: Degree of Cycle Aperture (Initial-Final)*

Figure 7.1.13 shows that almost half the cycles are Closed both at the beginning and at the end. However, from the pedagogical standpoint it is interesting to note that 35% of the cycles involve transformation of a request which is initially closed and limited into an open request that does not have only one possible answer by the end of the Cycle. This transformation is achieved through the teacher's effort to redefine the request, turning a closed question into a more complex, open problem.



*Fig.7.1.13. Distribution of Cycle Aperture (Initial-Final)*

Pearson's chi-squared test reveals significant differences with regard to Initial and Final Aperture of cycles according to activities chosen by Students ( $\chi^2 (6, 35) = 17,868; p = 0.007$ ). The graph shows that Student request when they choose SCA is always limited and well defined. In this situation, almost half the cycles remain the same after Teacher's Pedagogical Assistance, and the other half are redefined as more open and complex problems. SAAs differ because due to their very nature, they give rise to Student requests that are often open and complex right from the start. After Teacher intervention, the cycle is redefined into a different problem, equally unlimited, but more adjusted and manageable from the standpoint of learning.

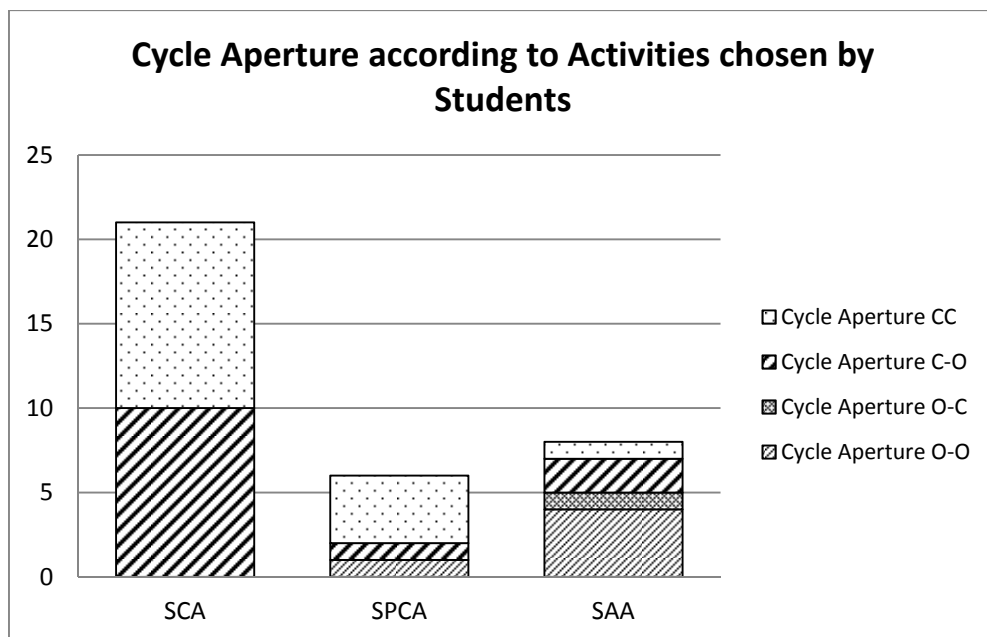


Fig 7.1.14. Cycle Aperture according to Activities chosen by Students

Following we summarise the main findings.

**Table 7.1.6. Summary of findings**

		Content	Student		Teacher		Interaction		
		ITC Uses	Request	Cognitive Demand	Pedagogical Assistance	Cognitive Demand	Participation Structure	Participation Level	Cycle's Degree of Aperture
Activities	SCA	Searching for Information	Factual and Conceptual	Acquiring Information	Procedural and Factual Assistance	Acquiring Procedures and Information	Long Cycle	With Student Participation	C-C C-O
	SPCA	Searching for Information and Procedure	Factual and Conceptual	Acquiring Information	Procedural and Factual Assistance	Acquiring Procedures and Information	Long Cycle	With Student Participation	C-C
	SAA	Transferring Information, Contrasting Sources and Arguing	Conceptual and Factual	Analysing information	Metacognitive Management	Analysing and Communicating Information	Long Cycle	With Student Participation	O-O



## Conclusions and Discussion

The following outline describes the pattern of behaviour in Jorge's classroom:

- 1- Students freely choose an activity, which may have different levels of complexity, the resolution of which requires use of ICT in specific ways.
- 2- The Activities chosen by the Student generally involve very similar factual or conceptual Demands which are primarily based on Acquiring Information. In contrast, the more complex activities make the student ask himself/herself questions involving greater cognitive complexity, based mainly on Analysing Information.
- 3- That Student Request moves the Teacher in different directions, with the more complex Requests involving more elaborate Assistance, such as Metacognitive Management. However – and this is probably one of the greatest virtues of this Teacher – we see a clear pattern of Teacher behaviour showing deliberate effort to redefine Student Request (which is usually factual and localised) into a more complex and elaborate Request (often procedural and extensive).
- 4- The Teacher's deliberate effort is reflected in the type of interaction, structure and level of participation developed in each of his Cycles. This gives rise to this characteristic pattern which begins with a limited, closed request and ends with a more complex request where the Student is almost always has the responsibility.

The detailed analysis of this particular case enabled us to draw some interesting conclusions regarding effective integration of ICT in the classroom. Firstly we highlight the crucial role of the learning activity as a starting point for the development of the whole system. The nature of the activity largely directs the student's approach and has a direct effect on the type of questions he/she will ask. The complexity of these questions is in turn the raw material which the teacher uses to encourage more in-depth student development. More complex questions encourage richer scenarios.

Secondly, and notwithstanding the above, the activity alone does not determine the learning process. It is the teacher who, through the Pedagogical Assistance provided, must redefine the student's request into something more complex and elaborate, which, in Vygotskian terms, involves moving from the Zone of Actual Development to the Zone of Proximal Development (Vygotski, 1978). In Jorge's particular case, the use he proposes for ICT responds to a given way of understanding what is involved in learning, the acquisition and validation of knowledge, the roles that should be played by teacher and student, and the content in that complex, dynamic network of relationships. Although there is hardly a trace of ICT-mediated relationship among students in his practice (even though he calls his learning environment collaborative), it does serve as an example of ICT being used by the student to think by himself/herself and with the teacher. This individual and joint thinking emerges as a result of prior planning of a teaching and learning scenario which reflects a certain pedagogical approach: freedom of choice for the student; complex, little defined problems that force the student to manage highly uncertain situations cognitively and emotionally; diversity in the number and reliability of information sources, etc. But beyond the planning and design involved in that ICT-mediated teaching and learning setting, its potential crystallises in the action through the use of those ICT in the classroom (Engeström, 1999a). Jorge's epistemic

goal-oriented classroom practice reflects an epistemological belief underlying each of his actions and materialising in pedagogic practice adapted to each student request. Namely, *the superabundance of information in our society and the multiple sources it comes from require the development of thinking and a critical attitude towards them*. This is the guiding principle that makes Jorge constantly redefine his students' demands that focus on information and the specific activity into demands that are more complex and global, such as the critical search for information and knowledge management.

### **Limitations of the study and future lines of research**

The example of Jorge's practice is mainly about integration of Information Technologies and to a much lesser extent, integration of Communication. Although the students work in groups, they are not instructed to resolve the activities jointly and cooperatively. On the contrary, fragmented, independent distribution of tasks is favoured.

A major limitation to this study is that it does not evaluate the learning achieved. Although we studied in depth the relationship among the parts of the interactive triangle, we cannot strictly answer the question of whether or not Jorge's proposed use of ICT actually favours more efficient learning.

Last but not least, we are aware of the limitations of using a Case Study as a research method for obtaining empirical evidence. We have consciously renounced the possibility of generalizing any results in exchange for producing a deep, detailed description of a case which is relevant in itself.

Future studies should overcome these limitations in order to achieve more in-depth conclusions regarding the integration of ICT in the classroom as psychological instruments.

### **Acknowledgement**

The Spanish Ministry of Economy and Competitiveness has supported this research through the Project EDU2013-47593-C2-1-P.

### **References**

- de Aldama, C. & Pozo, J.I. (2016). How ICT are used in the classroom: A study of teachers' beliefs and uses, *Electronic Journal of Research in Educational Psychology*
- Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. NY: Addison Wesley Longman
- Balanskat, A., Blamire, R., & Kefala, S. (2006), The ICT Impact Report. A review of studies of ICT impact on schools, European Schoolnet, Brussels.
- Bauer, J., & Kenton, J. (2005). Toward technology integration in schools: Why it is not happening. *Journal of Technology and Teacher Education*, 13, 519–546.
- Bloom, B.S. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals*, Handbook 1: Cognitive Domain. 1956, NY: McKay
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind experience, and school*. Washington DC: National Academy Press.

- Claxton, G. (1990). *Teaching to learn. A direction for education*. Londres, Cassell
- Coll, C. & Monereo, C. (Eds.). (2008). *Psicología de la educación virtual*. Madrid: Morata
- Davies, R. S., & West, R. E. (2014). Technology integration in schools. In *Handbook of research on educational communications and technology* (pp. 841–853). New York: Springer.
- Engeström, Y. (1999a) Activity theory and individual and social transformation, in: Y. Engeström, R. Miettinen & R-L. Punamäki (Eds) *Perspectives on Activity Theory*, Cambridge, Cambridge University Press.
- Erickson, F. (1982). Classroom discourse as improvisation: relationships between academic task structure and social participation structure. En L. CH.WILKISON (comp.), *Communicating in the classroom* (153-181). New York:Academic Press.
- European Schoolnet (2013a). Survey of schools: ICT in education: benchmarking access, use and attitudes to technology in Europe's schools. Luxemburgo, Oficina de Publicaciones de la UE.
- Fernández-Enguita, M. (2013). Contra todo pronóstico. Infraestructura, formación y...dirección: una exploración del uso de las TIC en el aula, con algunas sorpresas. En *Informe español TALIS*, p.77-104
- Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers ' use of educational technology in U . S . public schools : 2009* (NCES 2010–040) . Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.
- Kirsh, D. & Maglio, P. (1994). On distinguishing epistemic from pragmatic action, *Cognitive Science*, 18, 513-549
- Kozma, R. B. (2003). ICT and educational change: A global phenomenon. In R. B. Kozma (Ed.), *Technology, innovation, and educational change: A global perspective* (pp. 1-18). Eugene: International Society for Technology in Education.
- Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory Into Practice*,41(4), 212.
- Llorente, M.C., Barroso, J. y Cabero, J. (2015). Las Tecnologías de la Información y Comunicación: principios para su aplicación, integración y selección educativa. En J. Cabero y J. Barroso (Coords.), *Nuevos retos en Tecnología Educativa* (pp. 41-67). Madrid: Síntesis
- Newhouse, C. P., & Clarkson, B. D. (2008). Using learning environment attributes to evaluate the impact of ICT on learning in schools. *Research and Practice in Technology Enhanced Learning*, 3, 139-158.
- OCDE-DeSeCo (2005). *Definition and Selection of Key Competencies: Executive Summary*
- Olson, D. R., & Bruner, J. S. (1996). Folk psychology and folk pedagogy. In D. R. Olson, & N. Torrance, *The Handbook of education and human development. New models of learning, teaching and schooling* (pp. 9–27).
- Oxford: Blackwell.Pérez-Gómez, A.I. (2012). *Educarse en la era digital*. Ediciones Morata
- Piaget, J. (1974). *La prise de conscience*. París, P.U.F.
- Pozo, J.I. (2008). *Aprendices y maestros. La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J.I. & Postigo, Y. (2000). *Los procedimientos como contenidos escolares*. Barcelona: Edebé
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., & de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.

- Sánchez, E., García, J.R., Castellano, N., de Sixte, R., Bustos, A. & García-Rodicio, H. (2008). Qué, cómo y quién: tres dimensiones para analizar la práctica educativa, *Cultura y Educación*, 20 (1), 95-118
- Sawyer, R. K. (2006). *Explaining Creativity: The Science of Human Innovation*, New York: Oxford University Press.
- Starkey, L. (2012). Teaching and learning in the digital age. New York. NY: Routledge
- Stodolsky, S. S. (1988). The subject matters: Classroom activity in math and social studies. Chicago: University of Chicago Press.
- Tondeur J., Cooper M. & Newhouse C.P. (2010a) From ICT coordination to ICT integration: a longitudinal case study. *Journal of Computer Assisted Learning* 26, 296–306.
- Tondeur, J., Kershaw, L. H., Vanderlinde, R. R., & van Braak, J. (2013). Getting inside the black box of technology integration in education: Teachers' stimulated recall of classroom observations. *Australasian Journal of Educational Technology*, 29(3), 434-449.
- UNESCO Institute for Statistics. (2014). *Information and communication technology (ICT) in education in Asia: A comparative analysis of ICT integration and e-readiness in schools across Asia*. Retrieved September, 2015, from <http://www.uis.unesco.org/Communication/Documents/ICT-asia-en.pdf>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

### ***Estudio III-Artículo IV***

---

de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In *SAGE Research Methods Cases*. London, United Kingdom: SAGE Publications, Ltd

### Abstract

This case study is based on a research conducted in 2014, whose framework is the integration of Information and Communication Technologies (ICT) as learning tools in educational contexts. During the last decades the number of works about this topic has increased exponentially, yet, some key points of this phenomenon are still unknown, largely as a consequence of the lack of research in natural settings.

This study looks carefully at the Content of Learning, the Teacher and the Students, three main elements in any formal educational context, and analyzes their relation when they are mediated by ICT. To do this, we decided to conduct a case study based on one teacher who showed high proficiency using ICT in previous studies (de Aldama & Pozo, in press) and we observed and analyzed his practice in the classroom.

In this paper we describe the whole research process followed, based on the content analysis method, from early stages, when we got just too general ideas, until we developed specific and useful categories of analysis. Additionally, we show some difficulties we found during the research process and propose some tips to face them.

**Keywords:** ICT integration, teacher pedagogical practice, socioconstructivist learning, analysis of content

### Learning Outcomes

“By the end of this case students should be able to”:

- Understand how content analysis method is related to the key questions derived from our theoretical framework (*what* should I look at?, *where* should I look at?...)
- Identify the basic principles of the content analysis.
- Know the procedure to develop categories: *feed-back looping process*.
- Understand the importance of developing clear categories and specific *coding rules*.

### Case Study

*Project Overview and Context: Integration of ICT in formal education as learning tool*

“*The age of spiritual machines: when computers exceed human intelligence*” is the title of a Ray Kurzweil’s book published in 2000, who is a computer scientist and prestigious engineer of Google. Although this kind of sentences seems to belong to science fiction, the truth is that our daily life, at least in developed countries, is completely shaped by these devices. We use Information and Communication Technologies (ICT) almost for everything: to search information, to know the road conditions, to do sport, to design a project or just for fun and to chat with friends and family. Almost any activity that you can imagine is, or could be, mediated by ICT.

Education is affected by these technologies too. As Voogt and Pareja-Roblin noticed (2012), some of the most important international frameworks in which the 21<sup>st</sup>’s century competencies are defined (as Definition and Selection of Competencies-DeSeCo- program of

OECD) agree with the fact ICT are key elements to develop such competencies. Some of their features, like the possibility of having access to information anywhere at anytime, seem to facilitate the acquisition of competencies such as collaboration and communication.

But the reality is more complex. The educational revolution that many observers anticipated when ICT were introduced in classrooms for the first time is actually a tale of gradualism, as Gill Kirkup and Adrian Kirkwood pointed out (2005). More recent works seem to indicate the same direction (Ashrafzadeh & Sayadian, 2015; Reid, 2014). You can check it out through your own experience. Do you remember how your teacher (from primary, secondary or higher education) used to use ICT in classroom? Just take a few seconds to think about it. Was it something “revolutionary” or just the same as always but through another format? We would bet for the second one.

Trying to understand this gap between expectations and real uses of ICT, a few years ago, in 2013, our research team conducted a study about the relationship between educational beliefs and uses of ICT as a learning tool in a Spanish primary school (de Aldama & Pozo, in press), as part of the first author’s PhD research project. At that time, we thought that if we understood how teachers perceived these devices, then we could propose them new and alternative uses.

We found something unexpected: beliefs and uses were not aligned. In other words, teachers’ educational beliefs about ICT were more complex and elaborate than how they actually used them in the classroom. One example: some teachers thought that these technologies were powerful instruments to manage information and knowledge, allowing students to collaborate and communicate with each other. However, when we observed their practice we found, for instance, that they used ICT to reproduce literal information.

Although many teachers tended to present this contradiction, we discovered some interesting exceptions. Especially one of them, in which the teacher (we will call him “Jorge”) showed sophisticated educational beliefs but also sophisticated ICT uses in his classroom. He actually proposed meaningful and complex activities mediated by these technologies where students had to collaborate. The educational context designed by him tried to take advantage of the ICT’s possibilities. All we knew about him at that moment was just what he had told us in previous interviews and open-ended questionnaires. Therefore, we decided to go further and analyze him and his practice in a deeper way because it could give us some important clues about ICT integration.

### *Research Design*

Conducting a research is a continuous decision making process. The better decisions you take, the higher quality your research will have. We decided to carry out this case study because describing and analyzing Jorge’s practice mediated by ICT could be an example of a “good practice”. The question we wanted to answer was: “What are the best conditions in a classroom mediated by ICT to encourage better learnings?” Since Jorge was teaching in different levels at that time, we asked him about the best and most enriching learning environment mediated by ICT designed by him. According to him, we finally decided to analyze Jorge’s practice in higher education, specifically the degree course Physical Activity and Sport

Sciences, because the fact that students are more skilled than those at lower levels suggested that there could be more complex uses of ICT. We observed and recorded two 3-hour face-to-face sessions over two weeks, as part of the subject "Sport Activities in Nature". The whole material was transcribed and transformed in text to be processed and analyzed.

Very briefly, students worked in small groups (3-5 students) with one/ several computers (depending on their availability) to resolve activities chosen freely from the Digital Learning Environment (DLE) which Jorge had designed previously. The DLE was a common webpage where Jorge had uploaded those activities. These were classified by Jorge into three different groups, according to the contents and procedures required. Depending on their decisions, the final evaluation would be different.

So, we got this enriching learning environment mediated by ICT and designed by a teacher with high computer literacy. How could we analyze this context in order to obtain as much relevant information as possible? According to Yin (1984), "one approach to successful analysis is to make case study data conducive to statistical analysis-by coding events into numerical forms, for example" (pp.99-100). That is what exactly content analysis does: "transform what is essentially qualitative evidence into some sort of quantitative evidence" (Remenyi, Money, Price & Bannister, 2002 pp.5-6). Our point of view is that analysis of content gives us a powerful tool to look at that learning environment in a systematic and analytic way and also with high standards of validity and reliability. Krippendorff defines this method "as the use of replicable and valid method for making specific inferences from text to other states or properties of its source" (Krippendorff, 1969, p.103). By texts we mean all sort of recorded communication (transcripts of interviews, discourse, protocols of observation, video tapes, etc), as Philip Mayring mentions (2000).

According to Mayring, we consider that analysis of content is based on three basic ideas: first of all, it follows specific rules of analysis. This means that the material has to be analyzed step by step through determined procedures, dividing the material into content analytical units. Second, the analysis is founded in categories which are developed and revised within the process of analysis. And last, but not least, all these measures have the aim to increase reliability and validity: any researcher, with enough training, using those developed categories to analyse our material should obtain the same results and conclusions that we did.

Back to our research, the decision to conduct a case study using analysis of content as method supposed a number of methodological challenges that we describe with more detail in the next section.

### *Research Practicalities*

As we said before, we chose this case because we got the intuition that it could contribute to a better understanding of ICT integration. But how could it help us? Reality does not say anything *per se*. It depends on the lens through which we look at it. Equations maybe are wonderful elements for mathematicians, but meaningless for builders. As we had just one case (one learning environment mediated by ICT) and two sessions of observation, we had to be pretty sure before collecting data that it was a meaningful and relevant case. We did it through several previous interviews and asking Jorge about his trajectory and career. If your



case study is longer, you should also check its relevance starting your analysis from the earlier steps of data collection (Creswell, 2013, León & Montero, 2015). Doing so, you might be able to change things that are not working as you expect before it is too late and you will be gathering data in a more strategic and specific manner. For instance, early analysis was crucial in the second study of one of the authors' doctoral dissertation (García-Pérez, 2014a). He was doing a case study of a secondary education school to illustrate how teachers can promote pupil participation in their classes and in the whole school organization. A larger school, with 84 teachers, seemed to be enough for the aim of studying good practices, in comparison with two smaller primary education schools studied previously (with 40 teachers in total) (García-Pérez, 2014b). However, by analysing data gathered during the first trimester of his fieldwork in secondary education, he decided to include another school in the study because of two main reasons. First, he could not find good participatory practices as easily as in the other study and there were contradictions among teachers and among different organizational arrangements (e.g., student representatives encouraged in the student council, but some teachers omitting pupil voices in their classrooms). Second, even teachers that were keen on fostering pupil participation reported important barriers they found in their daily activity (lack of flexibility, high pressure over external examinations...). It was not possible to answer the research question of "how can we promote pupil participation in secondary education?" studying only that school. Therefore, he included another school to find more teachers committed with pupil participation and he decided to collect data and make comparisons about the barriers perceived for pupil participation in this educational level.

Coming back to the description of content analysis procedure, as we mentioned above, is based on categories. Categories are the lens through which you are going to look at your case study and analyse it. These categories are founded on your theoretical framework, so it is important that you know the key points of it to ask the right questions for your data. Starting from your theoretical background, categories are developed in a feedback loop process, trying to increase their validity and reliability step by step. The following scheme illustrates it:

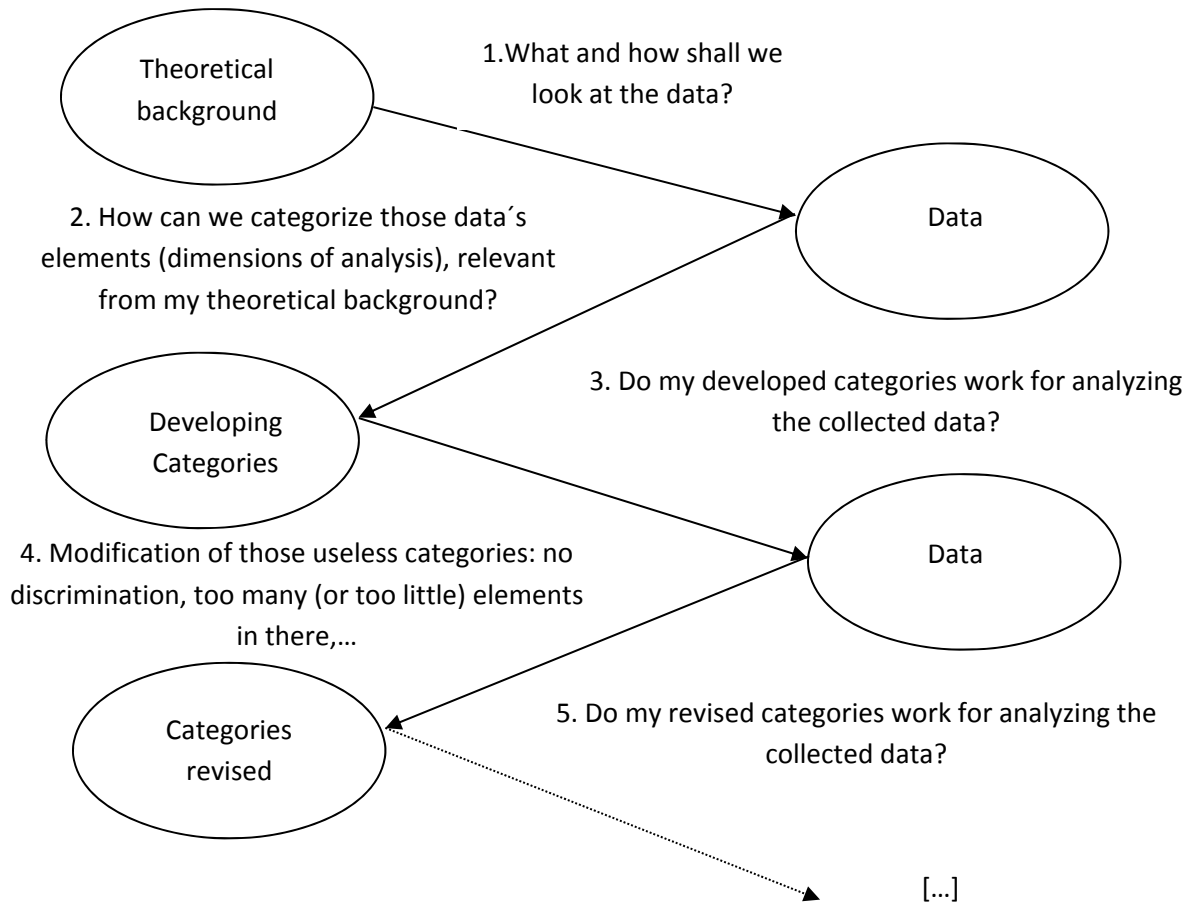


Fig 7.2.1: Procedure of analysis in content analysis

When the consensus between coders is enough (Mayring proposes around Cohens Kappa 0.7) means that categories are sufficiently reliable. In next section we describe how we put this method in action.

#### *Analysis of content in action*

Remember that the aim of the study was to know what the best conditions in a classroom mediated by ICT to encourage better learning were. This statement was not useful as research question because it was quite messy. As our rationale was quantitative, even when we were working with qualitative data, we needed to operationalize that question in terms of variables. What were the independent and dependent variables? It was time to come back to our theoretical background. What variables are important from a socioconstructivist point of view? According to Coll & Monereo (2008), there are three main components in any classroom: a teacher, a learner and the content they are working. That is what the authors call the “interactive triangle”. In our particular case, ICT were mediating the relationship between these elements. The following figures represent two possible types of relationship into the “interactive triangle”:

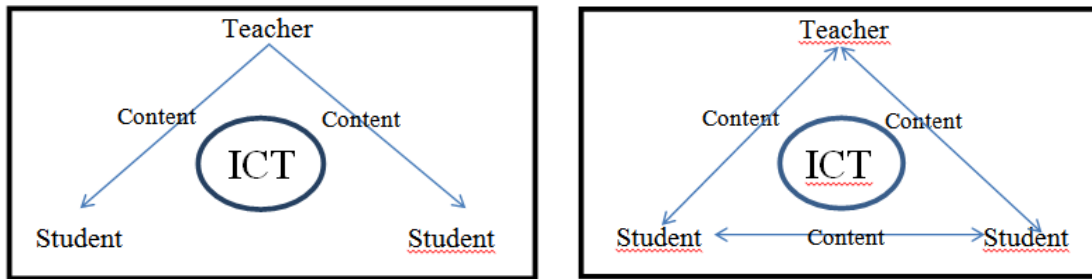


Fig. 7.2.2. Types of Relationship among the parts of the interactive triangle

The first figure represents a situation controlled by the teacher, who transmits the content to their students, who do not communicate among them. The second figure illustrated a much more open situation, where students participate in the learning context and interact with each other.

Following this proposal we had already what we exactly wanted to see in our data: the role of the teacher, the students, the content of learning and how ICT mediated those relationships. We were in the first step of analysis (see Figure1 above). Now it was time to decide *where* to go to see those elements. We had to divide the material in smaller units, so we chose *Communication Cycles* as our unit of analysis. *Communication Cycles* are the basic communication units in any dialogical process between teacher and student (Erickson, 1982; Sánchez et al., 2008; Stodolsky, 1988). Each Communication Cycle comprises the verbal exchanges needed to reach an agreement with regard to a given matter. The following exchange is an example of a *Communication Cycle*:

Student: For type of accident, does it mean accidents in nature?  
 Jorge: This is the same question that Jose asked me. Have you searched?  
 S: We put “types of accidents” and we got home accidents, falls...  
 J: Types of accidents? Let me see...let me, let me see how the question is asked on the blog.  
 S: What types of accidents are there...  
 J: In nature, in sports activities in nature, the question is incomplete. Otherwise, it’s never-ending, of course (Cycle 3)

There are different kinds of *Communication Cycles*, depending on the structure of the interaction (who begins and ends the Cycle), who participates (Teacher-Student; Teacher-Students; Student-Student...), the content of the interaction, etc.

To summarize, we had our material divided in analytical units called Communication Cycles, where the elements of interactive triangle relate in specific way. Figure 7.2.3 shows the general structure of a session:

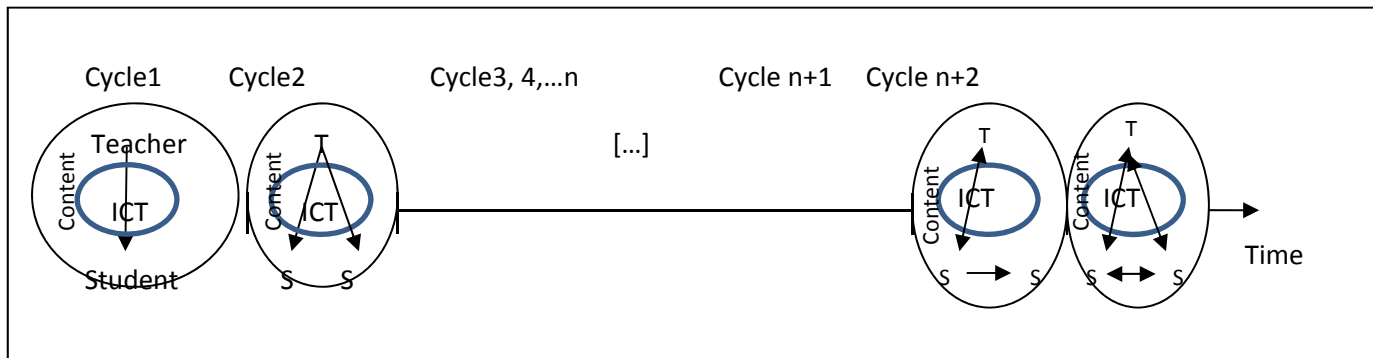


Fig.7.2.3. Structure of session according to Cycles of Communication

Thus, with these lenses we approached the material for the first time and then we became aware about something important. The classroom activity followed a specific structure that was repeated nearly all the time. First of all, students freely selected an Activity or Content of Learning from the Digital Learning Environment (DLE). The Content selected required specific Uses of ICT. The Content, and how students had to work with it through ICT, set a series of cognitive difficulties for the Student, which became a Request to the Teacher (usually in form of a Question). Then, the Teacher provided certain Pedagogical Assistance with a given Cognitive Demand for the Student, according to the Request. The way that all these elements interact among them was not always the same. The following outline describes this organization:

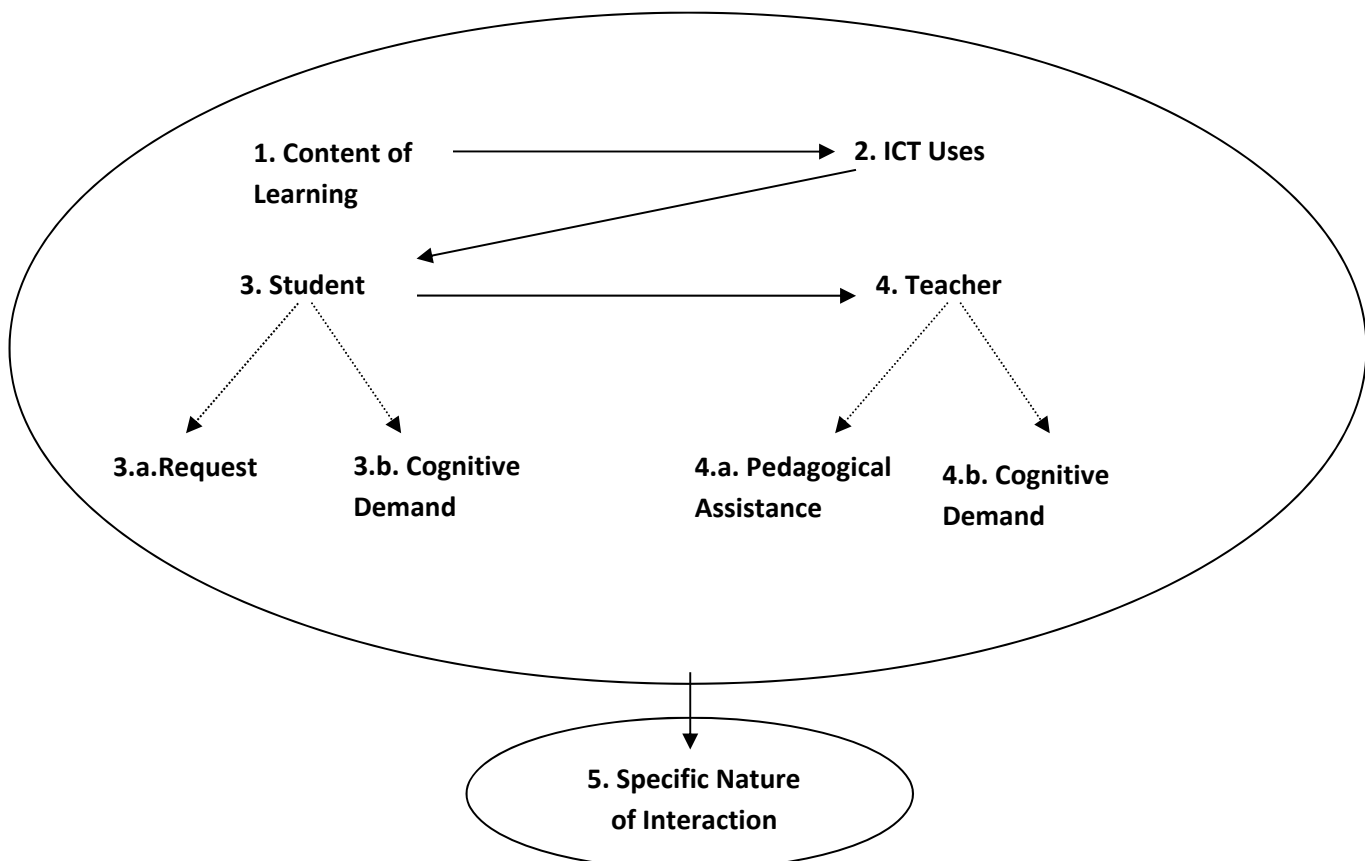


Fig.7.2.4. Classroom Activity Structure and dimensions of analysis

By this time we were already in step 2 (see Figure 7.2.1). *How can we categorize those data's elements (dimensions of analysis), relevant from my theoretical background?* Again, we had to look back to our framework. All those elements could take many different forms, but we were interested just in those relevant for our theoretical framework. As we were looking for the best conditions to encourage better learning, we had to categorize each dimension from the worst to the best condition for learning. Categories should be discriminative. Before that, we needed to be sure what we understand about "good learning". As Juan Ignacio Pozo points out (2008), we can identify two signs of good learning: it has to cause lasting changes and it has to be transferable to other situations, roughly speaking. Briefly, meaningful and situated content of learning encourages better learning than isolated and decontextualized content. For instance, memorizing a list with Europe's Rivers causes less lasting changes and is more difficult to transfer to another situation than elaborating a conceptual map where it is explained how those rivers influence our way of life. With the rest of dimensions it is pretty similar. It is desirable to use ICT to search information and contrast sources than just access to given information. Related to the student's request, it is not the same when they wonder about a fact ("what is the name of that river?") than when they wonder about how to resolve real and complex problems ("How could we use the rivers' power to produce energy?"), and so on.

Bearing these ideas in mind, we developed the first set of categories and subcategories. We got seven dimensions of analysis (see Figure 7.2.4) and we had to categorize each one. First of all, we defined each dimension in order to delimit them. Once we did it, then we went forward to define categories. In this first approach we were extremely exhaustive. For instance, we identified 19 different Pedagogical Assistances that Jorge gave to their students. Categories should be exhaustive and discriminative. It means that we had to be able to categorize any Jorge's Pedagogical Assistance and two categories shouldn't appear always together. Jorge sometimes informed, other times explained, suggested, ordered, corrected, asked and so forth, but not always two or more of them at the same time. Otherwise, it would mean that those categories would not be discriminative.

Once we defined and illustrated each category with an example, we went back to the material to check how those categories worked (step 3 in Figure 7.2.1). To do this, two coders from the research team analyzed approximately 10% of material, approximately 10-15 Cycles of Communication. The result was quite discouraging. Most of those categories just appeared once or, at best, twice. It was not very useful because categories were supposed to group elements that share some features. Therefore, we went back to categories for revision (step 4 in Figure 1).

In this step 4, our aim was to group categories and subcategories in wider units. For instance, at the beginning of the process we identified the category "asking" into the Teacher Pedagogical Assistance Dimension. The Teacher could ask for many different reasons and intentions, so we elaborated a set of subcategories. Some of them were "asking for procedure", "asking based on simulation" and "asking for exemplify". In the first one, there is a given situation and Jorge asks their students how they can resolve it. In the second one, Jorge suggests an analogue situation and also asks their students what procedures they have to use to resolve it. In the third case, Jorge requests an analogue situation to resolve it. We decided

to group these three categories in just one because Jorge's aim was the same in all three cases: "to resolve a problem".

We did something pretty similar with other categories and subcategories and then we went back again to our material (step 5 in Figure 7.2.1). The result was better than the first time, but still disappointing. We improved a lot the coder agreement in those observable categories, like the Student Request. For instance, it was relatively simple to identify when students were asking just to confirm something ("Am I doing this well, right?"), to demand clarifications or instructions to keep going with the activity ("where can I find this information?") or when they got doubts about a specific issue ("I think that 'risk' means the possibility of something bad happening and the 'hazard' of the fact that something is dangerous and likely to cause damage, but I'm not completely sure, could you help me?").

It was quite different when we were analyzing internal dimensions, like the Cognitive Demand. In these cases, we could not observe directly what the mental processes behind the activity were, but we had to infer them. To do this, we used a theoretical model developed by Juan Ignacio Pozo & Yolanda Postigo in 2000. Very briefly, these authors established a hierarchy of cognitive processes when doing mental activities. From shallow processes that require just acquisition of new information to deeper processes that demand deductive-inductive procedures to make new inferences (see Pozo & Postigo, 2000; de Aldama & Pozo, in press, for better understanding).

The problem with the categories developed by this model is that their definitions are too general for working properly with particular examples. For instance, when students ask "How can I distinguish between 'risk' and 'hazard'?", what kind of Cognitive Demand is that? Are they trying just to acquire new information?, or are they trying to analyze and comprehend it? At this point, we had to develop very specific criteria or *coding rules* to identify when one example belongs to one category or another. And that was what we did during step 6 and followings until we got a reasonable coder agreement (approximately 70% of agreement).

For instance, we added into the "Acquisition of Information" category the next coding rule: "As long as students demand isolated facts, those examples will be categorized as Acquisition of Information". We did something similar with the "Analysis" category. We included the following coding rule: "As long as students elaborate conclusions which do not appear directly in the text, those examples will be categorize as Analysis". We added coding rules into "Comprehension and Organization" category too: "As long as students are able to illustrate an idea suggesting an analogy or using new examples, those will be categorized as Comprehension and Communication". Table 7.2.1 summarizes it:

**Table 7.2.1.** *Definition of categories, code rules and examples.*

	Category	Definition	Coding rules	Example
Dimension: Cognitive Demand	<i>Acquisition</i>	Acquiring new information. Procedures of finding, gathering, selecting and maintaining information	1. Students demand isolated facts 2. [...]	1. "Where can I find the definition of "hazard"?"
	<i>Analysis</i>	Drawing conclusions. Involves inferences and deductive-inductive procedures.	1. Students elaborate conclusions which doesn't appear directly in the text 2. [...]	1. "So, it means that when I'm exposed to a hazard I'm taking a risk, isn't it?"
	<i>Comprehension and Organization</i>	Simultaneous relationship of present and non-present information. Specific procedures for organization (outlines, conceptual maps, summaries, etc.).	1. Students are able to illustrate an idea suggesting an analogy or using new examples 2. [...]	1. "Ok, so if I cross the zebra crossing during red lights I'm taking a risk because there is a hazard/ danger, which is a car knock down me, isn't it?"
	[...]	[...]	[...]	[...]

### *Practical Lessons Learned*

We have explained how our research process was, from the beginning, when we got just some ambiguous intuitions and general statements, until the end of category elaboration, when we had already defined them with much more precision. Although there is a large body of literature about qualitative methodology and content analysis (for instance, Given, 2008; Karlsson & Sjovaag, 2016; Kohlbacher, 2006; Krippendorff, 2004; Lewis, Zamith & Hermida, 2013; Ryan & Bernard, 2000), we are going to set a list of suggestions that might help you during the process:

**1. Theoretical background.** Take your time to read and prepare yourself. The quality of your categories, and as a consequence your analysis, depends largely on how they are developed based on a solid theory.

**2. Research questions clear and easy to manage.** It is possible that at the beginning of your research process you just have general ideas or hypothesis. Try to make them as clear as you can. Otherwise, analysis could become too messy.

**3. Develop categories based on clear definitions and coding rules.** As we have said above, as long as your categories are clear and precise, they will work better. Try to suggest

very specific coding rules. If they are too general you probably will have some difficulties to achieve a proper code agreement.

**4. Inter-reliability.** Probably you will have uncountable number of meetings to improve the validity and reliability of your categories. Write down everything you arrange! Sometimes we trust too much in memory and it causes not few troubles. Try to be extremely organized and systematic.

**5. Be patient.** The process of developing categories is quite often slow and discouraging. One of the worst experiences is when you think one category works properly and then you find some examples that you and your colleague interpret in a completely different way. Don't worry, it's normal. Just keep calm and work. The point is that meeting by meeting you will be finding solutions.

### Conclusions

As we have tried to illustrate along the text, analysis of content is a method that let us reinterpret reality under theoretical dimensions. For instance, in our case we had a learning environment mediated by ICT. That reality was incommensurable in that way. To delimit it we developed categories of analysis through a long process. Once we did it and used those categories to reinterpret the reality, we got another meaningful reality from our theoretical framework. One interesting result that we obtained was that in most cases, while students presented requests with low Cognitive Demand, Jorge transformed that request in other with higher Cognitive Demand and gave it back to them. If we had not developed those categories we would not have been able to realize that. The following scheme shows it:

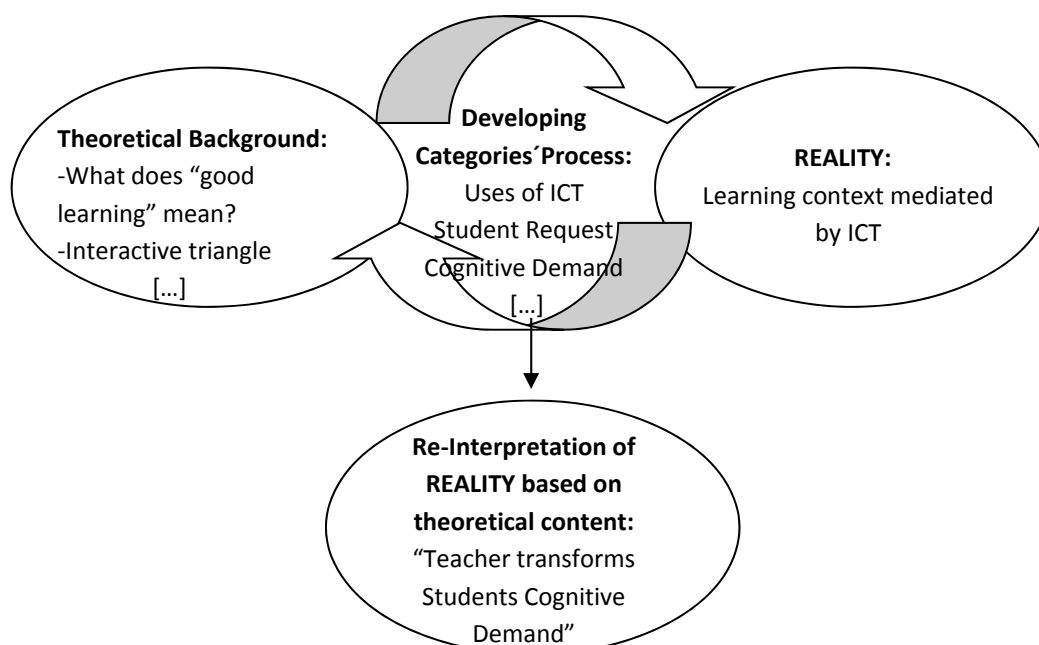


Fig. 7.2.5. General structure of content analysis process



To summarize, we have tried to show you some situations you may face if you finally decide to do your case study research using a content analysis method. We sincerely hope it can help you.

**Acknowledgement:** The Spanish Ministry of Economy and Competitiveness has supported this research through the Project EDU2013-47593-C2-1-P.

### Exercises and Discussion Questions

1- What are the implications of dividing the content of analytical units before or after collecting data? Justify your answer

2-Could you find another unit of analysis instead of Communication Cycles? What pros and cons should be taken into account?

3-Could you identify independent and dependent variables in our model of Classroom Activity Structure? (Content of Learning, Uses of ICT, Student Demand, Teacher Pedagogical Assistance and Interaction). Justify your answer describing the relationship between variables.

4-When we are developing categories, in the feed-back loop process, shall we always use the same examples to test them or not? Justify your answer describing the consequences of either situation.

5-We illustrated the problems we got as consequence of being too exhaustive at the beginning of the categories developing process. Could you figure out what would have been the problems if we had been too general? Enumerate them.

---

### Further Readings

Mayring, P. (2000). Qualitative Content Analysis, *Forum Qualitative Social Research*, Vol 1, nº 2

Kohlbacher, F (2006). The use of qualitative content analysis in case study research. *Forum Qualitative Social Research*, Vol 7, nº 1

### Web Resources

Jorge's Digital Learning Environment

<https://gestiondelriesgoenlanaturaleza.wordpress.com/>

### References

de Aldama & Pozo (in press) How are ICT used in the classroom? A study of teachers' beliefs and uses, *Electronic Journal of Research in Educational Psychology*

Ashrafzadeh, A., & Sayadian, S. (2015). University instructors' concerns and perceptions of technology, *Computers in Human Behavior*, 49, 62-73

Creswell, J. W. (2013). *Research design. Qualitative, quantitative and mixed method approaches* (4<sup>th</sup> ed.). Thousand Oaks, CA: Sage.

- Erickson, F. (1982). Classroom discourse as improvisation: relationships between academic task structure and social participation structure. In Wilkinson, L.C. (comp.), *Communicating in the Classroom* (153-181). New York: Academic Press.
- García-Pérez, D. (2014a). Hacia una escuela participativa: estudio cualitativo de buenas prácticas de participación en educación primaria y secundaria. [Towards a participatory school: qualitative case study of good participatory practices in primary and secondary education]. Unpublished doctoral dissertation, Faculty of Psychology, Autonomous University of Madrid. Available at <https://repositorio.uam.es/handle/10486/664105>.
- García-Pérez, D., & Montero, I. (2014b). Organización y Fomento de la Participación del Alumnado en Educación Primaria. Un Estudio Cualitativo de Casos. [Management and Encouragement of Pupil Participation in Primary Education: A Qualitative Case Study] *Multidisciplinary Journal of Educational Research*, 4(2), 211-238.
- Given, L.M. (ed.) (2008). *The Sage Encyclopedia of Qualitative Research Methods*. London: Sage Publications, Volume 1 & 2.
- Karlsson, M., & Sjøvaag, H. (2016). Content Analysis and Online News: Epistemologies of analysing the ephemeral Web. *Digital Journalism*, 4(1), 177-192.
- Kirkup, G., & Kirkwood, A. (2005). Information and communications technologies (ICT) in higher education teaching – a tale of gradualism rather than revolution, *Learning, Media and Technology*, 30(2), 185–199.
- Kohlbacher, F (2006). The use of qualitative content analysis in case study research. *Forum: Qual. Social Res.* 7, 1.
- Kurzweil, R. (1999). *The age of spiritual machines*. New York: Penguin Books.
- Krippendorff, K. (1969). Models of messages: three prototypes. In G. Gerbner, O.R. Holsti, K. Krippendorff, G.J. Paisly, & PhJ. Stone (Eds.), *The analysis of communication content*. New York: Wiley.
- Krippendorff, K. (2004) *Content Analysis: An Introduction to Its Methodology* (2<sup>nd</sup> ed.). London: Sage Publications.
- León, O. & Montero, I. (2015). *Métodos de investigación en Psicología y Educación. Las tradiciones cuantitativa y cualitativa* [Research methods in Psychology and Education. The quantitative and qualitative traditions] (4<sup>th</sup> ed). Madrid: Mc-Graw-Hill.
- Lewis, S. C., Zamith, R., & Hermida, A. (2013). Content analysis in an era of big data: A hybrid approach to computational and manual methods. *Journal of Broadcasting & Electronic Media*, 57(1), 34-52.
- Mayring, P. (2000). Qualitative Content Analysis, *Forum Qualitative Social Research*, Vol 1, nº 2.
- Pozo, J.I. (2008). *Aprendices y maestros. La psicología cognitiva del aprendizaje* [Learners and teachers. Cognitive Psychology of learning]. Madrid: Alianza Editorial.
- Reid, P. (2014). Categories for barriers to adoption of instructional technologies. *Education and Information Technologies*, 19(2), 383-407.
- Remenyi, D., Money, A., Price, D., & Bannister, F. (2002). The creation of knowledge through case study research. *Irish Journal of Management*, 23(2), 1.
- Ryan, G. & Bernard, H. (2000). Data management and analysis methods. In: N.K. Denzin & Y.S. Lincoln (eds). *Handbook of Qualitative Research* (2<sup>nd</sup> ed). London: Sage Publications, 2000; 769–802.

- Sánchez, E., García, J.R., Castellano, N., de Sixte, R., Bustos, A. & García-Rodicio, H. (2008). Qué, cómo y quién: tres dimensiones para analizar la práctica educativa [What, how and who: three dimensions to analyze educational practice], *Cultura y Educación*, 20 (1), 95-118
- Stodolsky, S. S. (1988). *The subject matters: Classroom activity in math and social studies*. Chicago: University of Chicago Press.
- Voogt, J. & Pareja-Roblin, N. (2012). A comparative analysis of international frameworks for 21<sup>st</sup> century competencies: Implication for national curriculum policies, *Journal of Curriculum Studies*, 1-23
- Yin, R.K (1984). *Case Study Research: Design and Methods*, , Beverly Hills, GA: Sage Publications

### Contributor Biographies

Carlos de Aldama is Educational Psychologist and PhD Candidate at Autonomous University of Madrid, Spain. During years, he has researched different fields of motivation, such as sport psychology. His current interests are the study of ICT as learning tool, especially the integration of new technologies in formal education. He has participated in numerous research projects and published his work in different scientific journals and presented it in national and international conferences.

Daniel García-Pérez is PhD in Educational Psychology from Autonomous University of Madrid. Nowadays, he teaches different courses on social research methodology at the European University of Madrid. His research has been devoted to pupil participation in primary and secondary education. Currently, he is collaborating with the Autonomous University of Madrid in a project lead by the Vrije Universiteit Brussel that links ICT and self-regulated learning in primary education.

Juan-Ignacio Pozo is Professor at the Faculty of Psychology of the Autonomous University of Madrid, Spain, where he teaches topics related to psychology of learning. His research focuses on the processes of knowledge acquisition and conceptual change in a number of specific domains (e.g., physics, chemistry, history, geography, grammar, music). He has also studied how to change teachers and learners conceptions of learning as a requirement for school and curriculum transformation. He has published more than 20 books about specific domain knowledge, conceptual change and learning conceptions as well as papers in some of the more relevant journals in the domain of psychology and education. See for instance:

<https://scholar.google.es/citations?user=xdcDJSkAAAAJ>

<http://www.researcherid.com/rid/B-7575-2011>

## ***Estudio IV-Artículo V***

---

de Aldama, C. & Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool

### Abstract

For some years now the scientific community has been studying how videogames foster acquisition of certain mental representations of the world around us. Research to date suggests that the efficiency of videogames as learning tools largely depends on the instructional design in which they are included. This paper provides empirical evidence related to the use of the videogame *Angry Birds* and how it can modify students' conceptions regarding object motion. We selected a sample of 110 16- to 17-year-old students in post-compulsory secondary school. Our results show that 1) merely playing *Angry Birds* does not produce significant learning, 2) learning occurs when *Angry Birds* is guided by epistemic goals, i.e., with the aim of answering certain questions about how the world around us works. Students who used the videogame in this way were able to recognize more variables, provide better explanations and understand more fully the relationship between angle and distance, and 3) there was no significant difference between students who worked collaboratively in pairs and those who worked individually. In the light of these results, we discuss potential implications for the future.

**Keywords:** videogames, science education, secondary education, epistemic goals, interactive learning environments

### Introduction

For several decades now, the scientific and educational community has grown increasingly interested in videogames (although with some conceptual differences, often called serious games or games-based learning) as learning tools (Clark, Tanner-Smith & Killingsworth, 2016; Garris, Ahlers & Driskell, 2002; Nawrocki & Winner, 1983; Prestridge & de Aldama, 2016; Randel, Morris, Wetzel & Whitehill, 1992). Many papers have been published in different fields and subjects as wide-ranging as history (Froschauer, Merkl, Arends & Goldfarb, 2013), sport (Bideau et al., 2010) and medicine (Graafland, Schraagen & Schijven, 2012).

Despite the increasing use of videogames in educational contexts, outcomes have not always been positive (Girard, Ecalte & Magnan, 2013; Sitzman, 2011). A recent meta-analysis by Clark, Tanner-Smith and Killingsworth (2016) claims that using videogames significantly improves learning; however, other similar studies do not suggest the same. A review by Young et al. (2012) found empirical evidence in subjects such as language, history and physical education, but very little in the fields of science and mathematics.

Some conclusions are even contradictory. A review by Connolly, Boyle, MacArthur, Hainey & Boyle (2012) found direct association between use of videogames and perceptive, cognitive, behavioural, affective and motivational outcomes. A meta-analysis by Wouters, van Nimwegen, van Oostendorp & van der Spek (2013) found that the use of serious games as an instructional method was more effective in terms of learning than other more conventional methods, but did not improve student motivation. Some authors claim that they cannot draw reliable conclusions about the effectiveness of videogames and serious games in learning due to the major limitations existing in research (Girard, Ecalte & Magnan, 2013).

A possible explanation for such widely diverging results is that the educational use of videogames has been assessed in very different educational contexts. Sitzmann (2011)

emphasizes this idea, suggesting that videogames are more effective when included in adequate instructional programs. Very few videogames are designed well enough to produce significant learning by means of students merely playing the game (Tennyson & Jorczak, 2008). Pedagogical help is thus an essential scaffold for connecting instructional features in the videogame to planned learning goals. In this regard, Ke (2009) claims that the instructional context is crucial, in particular for the acquisition of factual knowledge and for students with less prior knowledge.

The aim of our paper is to contribute empirical evidence to the association between educational uses of the videogame *Angry Birds* with or without adequate pedagogical guidance and learning relevant concepts in the field of physics.

#### *Videogames and learning science and physics*

Science is one of the subjects where learning-related videogame use has most often been researched (Annetta, Minogue, Holmes & Cheng, 2009; Hsu & Tsai, 2013). Sadler, Romine, Stuart & Merle-Johnson (2013) used a videogame (*MissionBiotech*) to work on aspects of the Biology syllabus, finding significant learning at all levels, with a greater effect on students with lower academic level. A recent study by Cheng, Lin, She, & Kuo (2016) showed that using a videogame (*Virtual Age*) fostered holistic and global comprehension of scientific concepts, and that the effect was maintained in the long term.

Within learning science, *physics* is one of the subjects that have been the object of most research (Clark et al., 2011; Clark, Nelson, Sengupta & D'Angelo, 2009; Masson, Bub & Lalonde, 2011; Squire, Barnett, Grant & Higginbotham, 2004). The eminently abstract nature of the conceptual content of physics poses a major challenge to the learner, which is why Anderson and Barnett (2013) claim that videogames and simulators provide an excellent scenario for involving students in studying complex scientific concepts. Using the affordances of videogames fosters student involvement in a recursive process based on complex forms of thought. These authors claim that videogames and simulators enable visual representation of complex phenomena that would be difficult to reproduce by any other means (Anderson & Barnett, 2011). For example, in the field of *electromagnetism*, students are expected to develop mental models of magnetic fields and the movement of electrons based on complex abstractions, with no analogous experiences in daily life as a reference (Furio & Guisasola, 1998). Using videogames may help develop these representations (Gee, 2003; Squire, 2003). A practical example is the work of Mohanty and Cantu (2011), which proposes a series of videogame-mediated activities to work on aspects of dynamics and kinematics.

Using videogames as instruments for representation is consistent with new perspectives on human cognition, such as embodied cognition, which consider perceptive and embodied experience to be an essential basis upon which abstract concepts can be developed (Gibbs, 2006; Han, 2013). This theoretical model claims that our cognitive processes are based on multimodal representations that we acquire through corporeal experience provided by the senses (sight, hearing, touch, smell and taste) when we interact with the environment (Han, 2013). Based on these experiences, we construct mental models which serve as a starting point for subsequent learning and greater understanding of the more formal aspects (Black, 2010). As shown by some of the work published by Han's team (Han, Black, Paley & Hallman,

2009; Hallman, Paley, Han & Black, 2009) on application of forces and object motion, the richer the perceptive experience, the more elaborate the mental model acquired, and thus, the greater the likelihood of learning and understanding more abstract concepts.

#### *Angry Birds and learning about motion*

Learning physics thus usually confronts not only the difficulties involved in understanding conceptual contents, but above all, these embodied restrictions underlying intuitive conceptions – our everyday knowledge of the world around us (Pozo & Gómez-Crespo, 2005). This knowledge is often articulated through representations that are not easily accessible to our consciousness, in the form of implicit theories which are extremely resistant to change due to their enormous functionality (Pozo, 2014).

These intuitive conceptions are very useful, for example, for predicting object motion (Reiner, Proffitt & Salthouse, 2005; Ventura, Hu, Nye, & Zhao, 2015). McCloskey (1983) observed that the trajectory of an object launched from an airplane was often drawn as a straight line down to the ground rather than as a parabolic path, which is what occurs in reality.

Within the study of conceptions regarding object motion, one of the subjects that have attracted most attention among researchers is the effect of gravity and free fall (Kavanagh & Sneider, 2007). Most studies reflect the existence of the naive belief –particularly widespread among persons with little or no formal instruction in physics– that heavier objects fall faster than lighter objects (Champagne, Klopfer & Anderson, 1980; Oberle, McBeath, Madigan, & Sugar, 2005; Vicovaro, 2014). Rohrer (2002) called this phenomenon “the mass-speed belief”. Sequeira and Leite (1991) showed that 52% of a sample of 4th year physics students reasoned according to the “mass-speed belief”, revealing the extent to which the belief is impervious to formal physics instruction and resistant to change.

Vicovaro (2014) suggests that this belief originates from our sensory-motor experience. An object held in one’s hand exerts a force in the direction of the ground, called weight, which is proportional to the mass of the object. When the object is in free fall, its velocity depends only on the acceleration of gravity (if the effect of friction is ignored). For objects with greater mass, the force will be greater, but acceleration will remain the same ( $g$ ). Vicovaro suggests that “mass-speed belief” is an *extension* of our sensory-motor experience of holding objects, such that the same principle is transferred to the phenomenon of free fall.

Some authors believe that the use of videogames may facilitate formal instruction of this type of conceptual content (Clark et al. 2011; Mohanty & Cantu, 2011). Masson et al. (2011) used the videogame *Enigmo*, which allows students to observe and manipulate the trajectory of different objects, with the aim of modifying those naive conceptions. They found that students who had used the videogame improved their ability to develop and generate realistic trajectories. However, this learning outcome was limited because students were unable to transfer the knowledge to other situations as a result of the erroneous interpretation of angle trajectory.

The famous videogame *Angry Birds*, originally developed by Rovio in 2009, has also been used by some researchers to work on different contents related to kinematics and the development of scientific concepts (Rodrigues & Simeao Carvalho, 2013; Sun, Ye, & Wang, 2015). The game is based on the laws of physics applied to projectile motion ('parabolic motion') and its aim is to launch birds using a large slingshot to destroy pigs that are protected in different ways.



Fig.7.3.1. *Angry Birds* screenshot

Like other commercial videogames that follow principles of Newtonian physics for entertainment purposes (e.g. *Enigma*, *Switchball* and *Tiger Woods*), *Angry Birds* is not designed to foster connections between implicit knowledge and more formal understanding. In terms of Kirsh and Maglio (1994; see also Alderoqui-Pinus and Pozo, 2013), playing *Angry Birds* for fun is guided by a *pragmatic* goal, i.e., the aim is to succeed by passing each level satisfactorily. However, understanding the laws of physics underlying the motion of the birds when they are launched involves asking oneself questions that will modify the way the task is tackled. To continue with the terminology of Kirsh and Maglio, this kind of understanding involves being guided by *epistemic* goals, i.e., turning the world into a question with the aim of understanding the whys and wherefores of reality around us (Pozo, 2014).

Clark et al. (2011) highlight the need to scaffold students' use of videogames if they are to learn concepts of physics formally. Just as basketball players do not learn to represent the motion of the ball algebraically merely by making free throws, students do not understand principles of physics simply by playing videogames ruled by those principles. Koops and Hoevenaar (2012) claim that it is necessary to move from the "gaming state", where the aim is entertainment *per se*, to the "learning state", where the aim is to understand the phenomenon involved.

#### *Collaborative learning through use of videogames*

Numerous studies show that social interaction stimulates the development of conceptual knowledge (Brown & Palincsar, 1989; Ravenscroft, 2007; van Boxtel, van der Linden & Kanselaar, 2000). Teasley (1995) found that in a computer task where the aim was to develop scientific thought, students who worked in pairs developed more complex discourse than those who worked alone, concluding that this was a result of the demands of the



communicative act, which requires interlocutors to seek explanations and rationales in order to understand each other.

Some authors believe that videogames are relevant contexts for providing this type of opportunity for dialogue and collaboration (González-González & Blanco-Izquierdo, 2012; Jones & Issroff, 2005). In a review of conceptual change, argumentative dialogue processes and “digital dialogue games”, Ravenscroft (2007) concludes that digital technologies can mediate, catalyse and amplify fundamental human communicative processes in the pursuit of significant and deep learning. However, he also notes that it is essential not to replace dialogue-rich learning practices with ones that are communicatively impoverished, such as those with over-reliance on “interactive content”.

### Research questions

Based on the above, we posed the following research questions:

RQ<sub>1</sub>: How does using *Angry Birds* influence the development of concepts related to projectile motion? Specifically, how does it affect student perception of the influence of variables such as velocity, force, mass and angle on object motion?

RQ<sub>2</sub>: Does the way in which *Angry Birds* is used influence the development of concepts on projectile motion? Specifically, is there any difference in how the phenomenon is understood according to whether the practice was guided by a *pragmatic* goal or by an *epistemic* goal?

RQ<sub>3</sub>: Can using *Angry Birds* through either pragmatic or epistemic practice influence “naive belief” regarding the effect of mass on falling objects (“mass-speed belief”)?

RQ<sub>4</sub>: Is there greater conceptual elaboration of projectile motion when *Angry Birds* is played collaboratively in pairs than when it is played individually?

### Method

#### *Sample*

110 students (61 male and 49 female, mean age  $\bar{X}$ = 16.74) in post-compulsory secondary education from two schools in the Community of Madrid were grouped according to four different conditions. Table 7.3.1 summarises the main characteristics of the four groups.

**Table 7.3.1.** *Sample characteristics*

	Sample				
	Group 1: Experimental paired (GEP)	Group 2: Experimental individual (GEI)	Group 3: No instruction (GNI)	Group 4: Control (GC)	TOTAL
N	27	18	21	44	110
GENDER ♂/♀	23/4	10/8	7/14	21/23	61/49
AGE $\bar{X}$	17.32	16.70	16.72	16.48	16.74
PROCEDURE	Week 1	Pre	Pre	Pre	Pre
	Week 2	Traditional theoretical instruction and experimental paired phase	Traditional theoretical instruction and experimental individual phase	Traditional theoretical instruction and playing freely with <i>Angry Birds</i>	Traditional theoretical instruction
	Week 3	Post	Post	Post	Post

### *Procedure*

This study has quasi-experimental design with pre- and post- measures (León and Montero, 2015). Data were collected over three weeks. The different phases of the process are described below.

#### *Week 1: Pre Phase*

During this phase we evaluated prior knowledge of parabolic motion in the four groups. We prepared a task consisting of 16 activities in which students were asked to draw the trajectory of different objects in motion, in which in aspects such as velocity, angle and mass varied. Below are some examples.

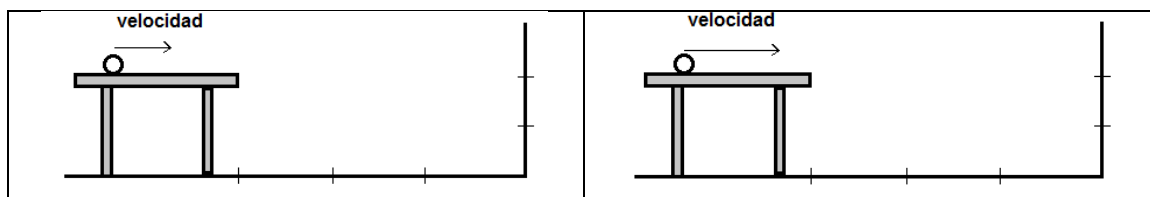


Fig.7.3.2. Example of two identical objects with uniform rectilinear motion and different velocity.

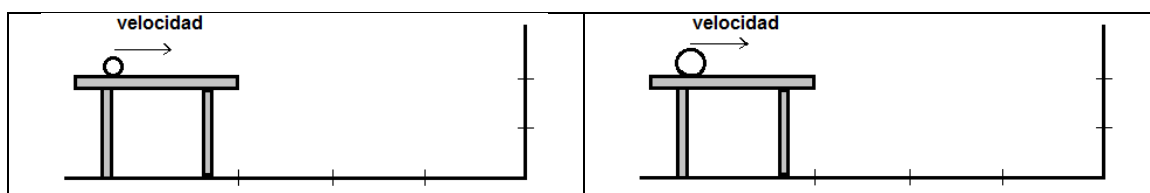


Fig.7.3.3. Example of two objects with different mass, uniform rectilinear movement and the same velocity.

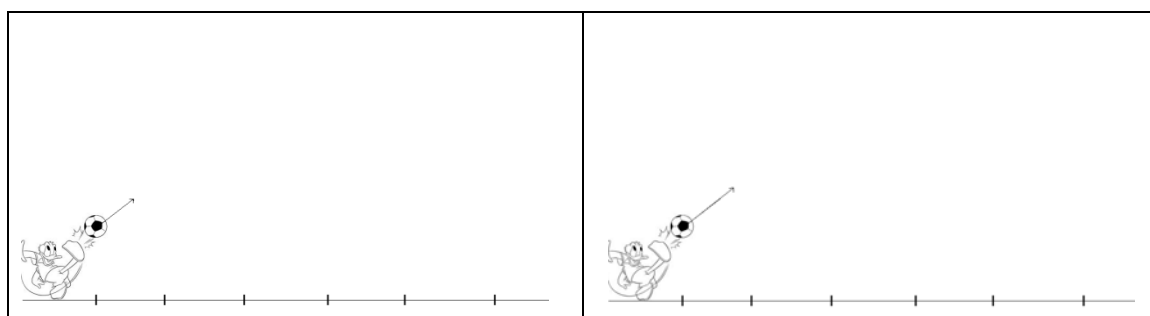


Fig.7.3.4. Example of two identical objects with parabolic motion and different velocity.

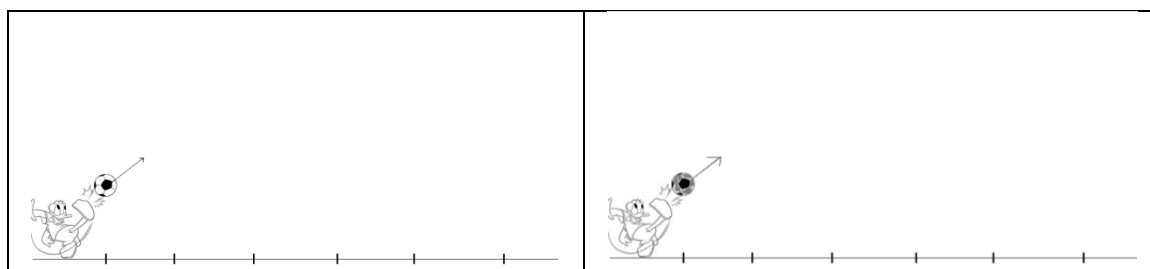


Fig.7.3.5. Example of two objects with different mass, parabolic motion and the same velocity.

In addition to these 16 activities, there was qualitative question asking students to explain to a fellow-student how to throw a stone as far as possible. This declarative dimension, requiring the student to put his/her ideas into words, was intended to gain a more complete picture of knowledge of projectile motion.

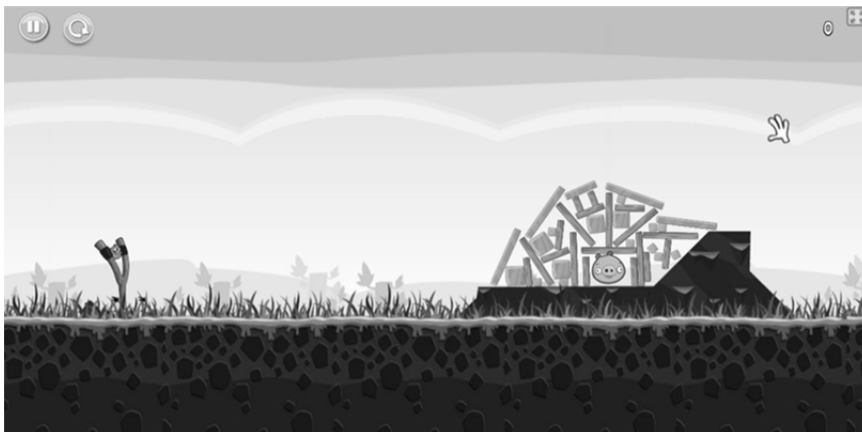
The two groups with lowest scores were assigned to the two experimental conditions (paired and individual), pursuant to the conclusions of Ke (2009) and Sadler et al. (2013) claiming that using videogames was more effective in students with lower levels of prior knowledge.

The work conducted during the second week is described below.

### *Week 2: Traditional theoretical instruction and experimental phase*

During week 2, all four groups received traditional instruction as part of the syllabus consisting of formal teaching of projectile motion. In the same week, the groups Experimental Paired (GEP), Experimental Individual (GEI) and No Instruction (GNI) used *Angry Birds* for approximately 1 hour 30 minutes following different rules. GNI used the videogame individually and freely, without any previous instruction or specific guidance. GEP and GEI used *Angry Birds* in pairs or individually, respectively, following specific instructions. Both groups were required to stay on a certain screen in the videogame (see Fig. 7.3.6) with the aim of answering the following questions:

1. How does **mass** influence the motion of the birds when they are launched? How did you reach this conclusion?
2. How does the **force** with which the slingshot is stretched influence the motion of the birds when they are launched? How did you reach this conclusion?
3. How does launching **angle** influence the motion of the birds when they are launched? How did you reach this conclusion?
4. Which would be the best combination of these variables to attain **maximum reach**?



*Fig.7.3.6. Angry Birds screen where students were required to work.*

We designed these questions with the intention of changing student goals when using *Angry Birds* from a *pragmatic* goal of passing on to the next screen, to an *epistemic* goal of understanding the physical phenomena underlying the parabolic motion of the birds when launched.

### *Week 3: Post Phase*

In this phase, the four groups were asked once again to resolve the 16 activities in the questionnaire and the qualitative section explaining how to throw a stone as far as possible.

### Data analysis

The quantitative section made up of the 16 activities was analyzed using SPSS software following the ANCOVA model to determine the effect of using *Angry Birds* on solving physics problems. Here, we evaluated students' answers by grouping items according to different variables related to projectile motion, namely:

*Effect of mass.* Did the student consider that a heavier object falls sooner than a lighter object?

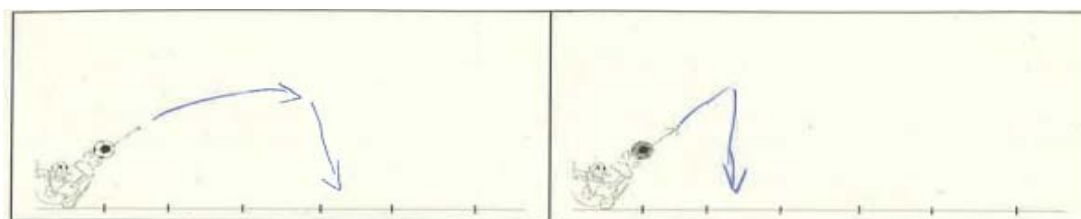


Fig.7.3.7. Example of “speed-mass belief”. The heavier object falls sooner than the lighter object even though they both have the same initial speed.

*Effect of velocity.* Did the student consider that an object at a higher velocity travels farther than an object at a lower velocity?

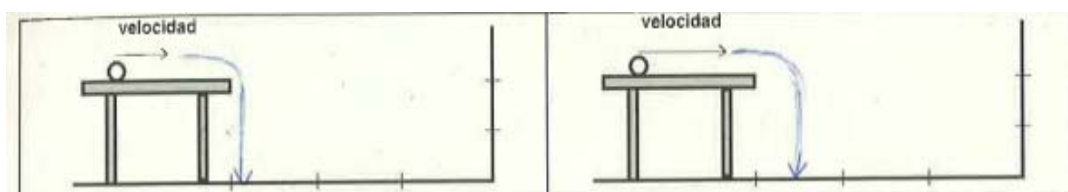


Fig.7.3.8. Example of correct answer for the effect of velocity on object motion.

*Trajectory described.* Is the trajectory described by the student correct?

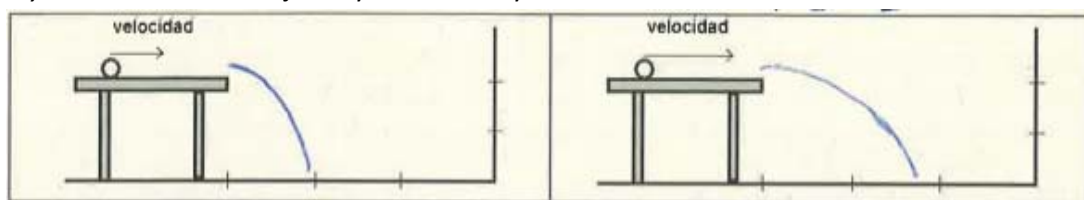


Fig.7.3.9. Example of correct description of the trajectory of object motion.

*Global score.* To what extent does the student consider all these variables upon drawing the trajectory for object motion?

Items were coded by three independent experts, attaining a final agreement of 90%.

For the qualitative section, students' answers to the question “How would you explain to a fellow student the best way to throw a stone as far as possible?” were ranked according to level of complexity considering the same variables as in the previous section, additionally including force and angle. Table 7.3.2 summarises the different levels.

**Table 7.3.2.** *Levels of complexity in explanations*

Levels of complexity in the explanation	Description	Example	Justification
L1	The variable(s) considered in the explanation are poorly defined or incorrect.	Example 1: "Consider posture, force and angle at which he/she throws." Example 2: "Throw at an angle of 10°."	Example 1 does not specify what posture, force and angle to consider. Example 2. It is incorrect to say that throwing at an angle of 10° maximises distance.
L2	The variable(s) considered in the explanation are well defined.	Example: "Throw with the greatest force possible at an angle of 45°"	It is correct that an angle of 45° and maximum force will maximise distance.

The results were analysed using Pearson's non-parametric Chi-squared statistical test.

## Results

### *Analysis of answers to questionnaire*

The results in this section revealed significant differences only for overall score. Table 7.3.3 summarises the most outstanding results of the analysis of answers to the questionnaire.

**Table 7.3.3.** *Summary of answer to the questionnaire*

Group	How does MASS affect parabolic motion?			How does VELOCITY affect parabolic motion?			Describe the TRAJECTORY in parabolic motion.			OVERALL SCORE		
	PRE (%)	POST (%)	ΔL (%)	PRE (%)	POST (%)	ΔL (%)	PRE (%)	POST (%)	ΔL (%)	PRE (%)	POST (%)	ΔL (%)
GEP	17	35	18	93	100	7	48	62	14	40	57	17*
GEI	15	20	5	94	100	6	46	65	9	37	51	14**
GNI	6	27	21	98	100	2	62	69	7	46	57	11
GC	9	17	8	98	99	1	63	68	5	47	52	5*,**

(ΔL = Improvement of learning) \*GEP<sub>i</sub>\*GC<sub>j</sub>. Difference between means (i-j)=0.12, p<0.01; \*\* GEI<sub>i</sub>\*GC<sub>j</sub>. Difference between means (i-j)=0.09, p<0.01

Several interesting conclusions can be drawn from Table 3. Firstly, all groups improve for all questions, which is logical, considering that all participants receive at least formal instruction on projectile motion. Secondly, we shall look at how answers vary according to the variable considered. For *mass* the percentage of correct answers is significantly low, no doubt reflecting widespread “mass-speed belief” (Rohrer, 2002), and there is little improvement, revealing strong resistance to change of this naive idea. In contrast, *velocity* has a very high percentage of correct answers both pre- and post-test, where there is clearly a ceiling effect, since most students correctly conceive the relation between speed and movement in the pre-test. We analyse overall scores in greater detail below.

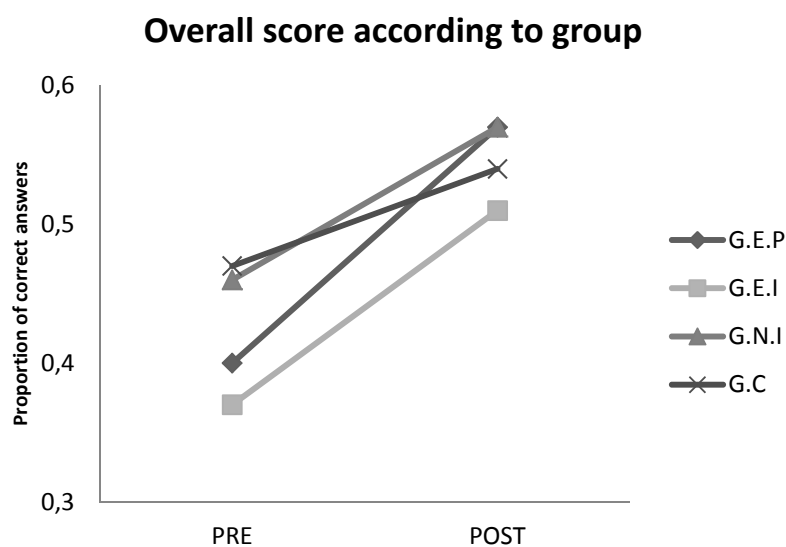


Fig.7.3.10. Proportion of total correct answers per group.

Figure 7.3.10 shows that none of the four groups attains 50% correct answers in the pre-test, reflecting limited knowledge of the different factors that influence projectile motion. There are also significant differences between baseline for GEI and GC, as revealed by analysis of variance ( $F(3, 106) = 2.59, p < 0.05$ ). This is a consequence of the socioeconomic differences between schools, with GC having a higher level than GEI. Analysis of covariance (ANCOVA), using as a covariable the pre-test, reveals significant differences between experimental groups (GEP and GEI) and GC ( $F(3, 106) = 0.12, p < 0.01, \eta_p^2 = 0.1$ ;  $F(3, 106) = 0.09, p < 0.01, \eta_p^2 = 0.1$  respectively). This means that effect size of instructions, though small, produced a significantly higher learning gain in the experimental groups (GEP=17%; GEI=14%) than in the control group (GC=5%), which only improved as a result of formal instruction. Finally, it is relevant to note that none of the four groups surpasses 60% correct answers in the post-test, indicating that improvement was limited, and practically non-existent for the effect of mass on projectile motion, where the best group (GEP) only attained 35% correct answers.

*Analysis of explanations on how to throw a stone*

As described above (see Method), in this section we asked students to explain how to throw a stone as far as possible. Table 7.3.4 shows the distribution of explanations provided by participants in the pre and post tests. Students in the Paired and Individual Experimental Groups improved by 48% and 62% respectively from L1 explanations (poorly defined variables or erroneous explanations) in the pre-test to L2 explanations (well-defined variables and correct explanation) in the post test. In the Control Group, however, improvement was only 21%. These differences were significant ( $\chi^2(3, 106) = 15.83, p < 0.05$ ).

**Table 7.3.4.** *Distribution of groups according to Pre- and Post-test explanations*

				Group							
				GEP		GEI		GNI		GC	
				N	%	N	%	N	%	N	%
EL PRE	L1	EL POST	L1	6	22	3	19	7	33	28	67
			L2	13	48	10	62	6	29	9	21
	L2	EL POST	L1	0	0	0	0	3	14	1	2
			L2	8	30	3	19	5	24	4	10

EL PRE: Explanation level in Pre-test; EL POST: Explanation level Post-test.

The analysis of each variable considered independently in the explanations provided by students shows distinct behaviour between groups with regard to the perception of the effect of *angle* on launching. Table 7.3.5 summarises the way perception of the effect of angle was classified by students.

**Table 7.3.5.** *Perception of the effect of angle on launching.*

Perception of the effect of angle on launching	Description	Example	Justification
A1	Angle not considered or considered incorrectly.	Example 1: "Hold the slingshot, and the more you stretch the elastic, the farther the stone will go." Example 2: "Don't launch too high or too low, use an angle of about 30° with a lot of force"	Example 1. Does not consider angle, only considers force. Example 2. Considers angle incorrectly.
A2	Angle considered correctly.	Example: "Launch at an angle of 45°."	It is correct that a 45° angle maximises distance.



Fifty-six percent of the students in the Paired Experimental Group and 69% in the Individual Experimental Group improved from providing explanations that did not consider angle or considered it incorrectly to providing explanations that considered angle correctly, i.e., stating that a 45° angle maximises distance. In contrast, only 19% of students in the Experimental Group with No Instruction and 24% of the Control Group were able to change their conceptions. These differences were significant ( $\chi^2 (3, 106) = 21.56, p < 0.05$ ). Table 7.3.6 summarises the most outstanding results:

**Table 7.3.6.** *Distribution of groups according to perception of angle in pre- and post-tests.*

				Group							
				GEP		GEI		GNI		GC	
				N	%	N	%	N	%	N	%
Pre Angle	A0	Post Angle	A0	3	11	3	19	10	48	25	60
			A1	15	56	11	69	4	19	10	24
	A1	Post angle	A0	0	0	0	0	2	9	3	7
			A1	9	33	2	12	5	24	4	9

## Conclusions

This study provides empirical evidence in several directions. The research questions are discussed below in the light of the results.

RQ<sub>1</sub>: How does using *Angry Birds* influence the development of concepts related to projectile motion? Specifically, how does it affect student perception of the influence of variables such as velocity, force, mass and angle on object motion?

Analysis of answers to the questionnaire and explanations suggest the same conclusions: the mere fact of playing *Angry Birds* does not imply learning more formal aspects underlying projectile motion. Indeed, no significant difference was found for the influence of variables on object motion between the group with no instruction and the control group, whereas there were differences between the control group and the two groups that played with epistemic goals.

This result agrees with Clark et al. (2011), who state that real learning through videogames requires a scaffold provided by activities that will lead players to make their own beliefs explicit (Pozo, 2014; Pozo and Gomez Crespo, 2005) and contrast them with the experience provided by the game.

RQ<sub>2</sub>: Does the way in which *Angry Birds* is used influence the development of concepts on projectile motion? Specifically, is there any difference in how the phenomenon is understood according to whether the practice was guided by a *pragmatic* goal or by an *epistemic* goal?

The results show, albeit to a limited extent, that students who played *Angry Birds* guided by epistemic goals were able to 1) consider more variables when drawing the trajectory of objects in motion, 2) provide more elaborate explanations about how to launch objects as

far as possible and 3) have significantly better understanding of the relation between angle and distance.

RQ<sub>3</sub>: Can using *Angry Birds* through either pragmatic or epistemic practice influence “naive belief” regarding the effect of mass on falling objects (“mass-speed belief”)?

In this case we found no empirical evidence enabling us to assert that using *Angry Birds* guided either by pragmatic or epistemic goals modifies the “naive belief” regarding the effect of mass on falling objects. A possible interpretation is that the *Angry Birds* game does not provide a sensory-motor or perceptual experience of the effect of mass on movement (Vicovaro, 2014). In other words, it does not enable direct manipulation and observation of the relationship between mass and speed. As no alternative experience is provided to what we are exposed to daily in our relationship to objects, the naive belief regarding the effect of mass remains unchanged. This result, in line with Sequeira & Leite (1991), proves the strong resistance to changing this belief.

RQ<sub>4</sub>: Is there greater conceptual elaboration of projectile motion when *Angry Birds* is played collaboratively in pairs than when it is played individually?

The results reflect no significant difference between students working in pairs and individually.

### **Limitations and future research**

This study has some limitations which should be mentioned. Firstly, although we found a positive result for epistemic use of *Angry Birds* for learning concepts about object motion, its scope is limited. The effect might increase considerably if the game were played for a longer time. In addition, although the experimental session was coordinated with the teachers, it was conducted outside curricular activities and directed by members of the research team. Better integration in classroom dynamics and direction by the actual teacher might increase the effect observed. Further research should contrast these hypotheses.

Another major limitation is the distribution of participants in the different experimental conditions. Due to sample size, only students with lower prior knowledge used *Angry Birds* guided by epistemic goals, pursuant to the conclusions of Ke (2009) and Sadler et al. (2013). It would be interesting to provide empirical evidence of the effect of this type of practice on students with higher previous scores.

Another relevant aspect worth mentioning is the absence of significant differences between individual and paired experimental conditions. In contrast to the literature (Jones & Issroff, 2005; Ravenscroft, 2007), in our study, both experimental groups (paired and individual) resolved the tasks in a similar way. One possible interpretation of these results is that working in pairs had no effect as a result of the lack of deliberate planned instruction regarding *how* the participants should work in pairs. In other words, they were simply paired, but received no precise instructions to enable them to take advantage of the possibilities

provided by collaborative work. Further research should provide empirical evidence in this regard.

Despite these limitations, our work seems to point in a clear direction: the pedagogical value of the videogame *Angry Birds* materializes when it is used epistemically, i.e., when it is used with the aim of answering questions related to principles of physics that underlie the game and object motion in the world around us. This conclusion is consistent with those of Masson et al. (2011), who found that using the videogame *Enigmo*, which emphasises observation and manipulation of realistic trajectories, moderately improved ability to work out conclusions on object motion. However, this improvement was limited, since students were unable to transfer that knowledge to new situations. The authors attributed this result precisely to the absence in the videogame of an interpretative framework that would enable students to connect what they learned to other scenarios and contexts. In our study, *Angry Birds* has the same lack, which is why we supplemented it with specific instructions intended to modify the goal guiding students' use of the game.

Although the design of most commercial videogames reflects the laws of Newtonian physics quite well (as in *Angry Birds* or *Enigmo*), it does not foster user reflection or awareness of the underlying laws of physics. For example, *Angry Birds* does not explicitly indicate the launching angle or the mass of the different birds. This is why Clark et al. (2011) speak of the need to "scaffold" student use of videogames significant learning is to be achieved. Further research should look more deeply into how videogames and their different uses may foster the development of an epistemic mind.

**Acknowledgment:** The Spanish Ministry of Economy and Competitiveness supported this research through the Project EDU2013-47593-C2-1-P.

## References

- Alderoqui-Pinus, D. & Pozo, J.I. (2013) Epistemic Actions in Science Museums. Families Interacting with the Mirror Room Exhibit. *Revista de Psicodidáctica*, 18 (2), 275-292. <http://dx.doi.org/10.1387/RevPsicodidact.6934>
- Anderson, J., & Barnett, M. (2011). Using videogames to support pre-service elementary teachers learning of basic physics principles. *Journal of Science Education and Technology*, 20(4), 347-362.
- Anderson, J. L., & Barnett, M. (2013). Learning physics with digital game simulations in middle school science. *Journal of Science Education and Technology*, 22(6), 914-926.
- Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2009). Investigating the impact of videogames on high school students' engagement and learning about genetics. *Computers & Education*, 53(1), 74-85.
- Bell, D. (2009). Learning from second life. *British Journal of Educational Technology*, 40(3), 515-525.
- Bideau, B., Kulpa, R., Vignais, N., Brault, S., Multon, F., & Craig, C. (2010). Using virtual reality to analyze sports performance. *Computer Graphics and Applications, IEEE*, 30(2), 14-21.

- Brown, A. L., & Palincsar, A. S. (1989). Guided cooperative learning and individual knowledge acquisition. In L. B. Resnick, *Knowing, learning and instruction: essays in honor of Robert Glaser* (pp.395–451). Hillsdale, NJ: Lawrence Erlbaum.
- Caro, P. W. (1973). Aircraft simulators and pilot training. *Human Factors*, 15, 502-509.
- Champagne, A. B., Klopfer, L. E., & Anderson, J. H. (1980). Factors influencing the learning of classical mechanics. *American Journal of Physics*, 48, 1074–1079.
- Cheng, M. T., Lin, Y. W., She, H. C., & Kuo, P. C. (2016). Is immersion of any value? Whether, and to what extent, game immersion experience during serious gaming affects science learning. *British Journal of Educational Technology*.
- Clark, D., Nelson, B., Sengupta, P., & D'Angelo, C. (2009, October). Rethinking science learning through digital games and simulations: Genres, examples, and evidence. In *Learning science: Computer games, simulations, and education workshop sponsored by the National Academy of Sciences, Washington, DC*.
- Clark, D. B., Nelson, B. C., Chang, H. Y., Martinez-Garza, M., Slack, K., & D'Angelo, C. M. (2011). Exploring Newtonian mechanics in a conceptually-integrated digital game: Comparison of learning and affective outcomes for students in Taiwan and the United States. *Computers & Education*, 57(3), 2178-2195.
- Clark, D.B., Tanner-Smith, E.E. & Killingsworth, S.S. (2016). Digital games, design, and learning: A systematic review and meta-analysis, *Review of Educational Research*, 86 (1), 79-122
- Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2), 661-686.
- Froschauer, J., Merkl, D., Arends, M., & Goldfarb, D. (2013). Art history concepts at play with THiATRO. *Journal on Computing and Cultural Heritage (JOCCH)*, 6(2), 7.
- Furio, C. & Guisasola, J. (1998) Difficulties in learning the concept of electric field. *Science Education* 82(4):511–526
- Garris, R., Ahlers, R. & Driskell, J.E. (2002). Games, motivation and learning: A research and practice model, *Simulation & Gaming*, 33 (4), 441-467
- Gee JP (2003a) What videogames have to teach us about learning and literacy. Palgrave Macmillan, New York
- Gibbs, R. W. (2006). *Embodiment and cognitive science*. New York, NY: Cambridge University Press.
- Girard, C., Ecalte, J., & Magnan, A. (2013). Serious games as new educational tools: how effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted Learning*, 29(3), 207-219.
- González-González, C., & Blanco-Izquierdo, F. (2012). Designing social videogames for educational uses. *Computers & Education*, 58(1), 250-262.
- Graafland, M., Schraagen, J. M., & Schijven, M. P. (2012). Systematic review of serious games for medical education and surgical skills training. *British Journal of Surgery*, 99(10), 1322-1330.
- Hallman, G., Paley, I., Han, I., & Black, J. (2009). *Possibilities of haptic feedback simulation for physics learning*. In Proceedings of world conference on educational multimedia, hypermedia and telecommunications 2009 (pp. 3597–3602). Chesapeake, VA: AACE.
- Han, I. (2013). Embodiment: A New Perspective for Evaluating Physicality in Learning. *Journal of Educational Computing Research*, 49(1), 41-59.

- Han, I., Black, J., Paley, I., & Hallman, G. (2009). Feel, imagine and learn: Learning from visual and haptic simulations. *Subway Summit 2009*. New York: Fordham University.
- Hsu, C. Y., & Tsai, C. C. (2013). Examining the effects of combining self-explanation principles with an educational game on learning science concepts. *Interactive Learning Environments*, 21(2), 104-115.
- Jones, A., & Issroff, K. (2005). Learning technologies: affective and social issues in computer-supported collaborative learning. *Computers & Education*, 44, 395-408
- Kavanagh, C., & Sneider, C. (2007). Learning about gravity I. Free fall: A guide for teachers and curriculum developers. *Astronomy Education Review*, 5, 21-52.
- Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. *Handbook of research on effective electronic gaming in education*, 1, 1-32.
- Kirsh, D., & Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive Science*, 18(4), 513-549.
- Koops, M., & Hoevenaer, M. (2012). Conceptual change during a serious game: Using a Lemniscate model to compare strategies in a physics game. *Simulation & Gaming*, 1046878112459261.
- León, O. & Montero, I. (2015). *Métodos de investigación en Psicología y Educación. Las tradiciones cuantitativa y cualitativa* [Research methods in Psychology and Education. The quantitative and qualitative traditions](4<sup>th</sup> ed). Madrid: Mc-Graw-Hill.
- McCloskey, M. (1983). Intuitive physics. *Scientific American*, 248, 122-130
- Masson, M. E., Bub, D. N., & Lalonde, C. E. (2011). Video-game training and naïve reasoning about object motion. *Applied Cognitive Psychology*, 25(1), 166-173.
- Mohanty, S. D., & Cantu, S. (2011). Teaching introductory undergraduate physics using commercial videogames. *Physics Education*, 46(5), 570.
- Nawrocki, L.H., & Winner, J.L.(1983). Videogames: Instructional potential and classification, *Journal of Computer-Based Instruction*, 10 (3/4), 80-82
- Oberle, C. D., McBeath, M. K., Madigan, S. C., & Sugar, T. G. (2005). The Galileo bias: A naïve conceptual belief that influences people's perceptions and performance in a ball-dropping task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31, 643-653.
- Pivec, P., & Pivec, M. (2013). Immersed, but How? That Is the Question. *Human IT: Journal for Information Technology Studies as a Human Science*, 10(1).
- Pozo, J. I., & Gómez-Crespo, M. A. (2005). The embodied nature of implicit theories: The consistency of ideas about the nature of matter. *Cognition & Instruction*, 23(3), 351-387.
- Pozo, J.I. (2014) *Psicología del Aprendizaje Humano: adquisición de conocimiento y cambio personal*. Madrid: Morata
- Prestridge, S., & de Aldama, C. (2016). A Classification Framework for Exploring Technology-Enabled Practice—FrameTEP. *Journal of Educational Computing Research*, 0735633116636767.
- Reiner, C., Proffitt, D. R., & Salthouse, T. (2005). A psychometric approach to intuitive physics. *Psychonomic Bulletin and Review*, 12, 740-745.
- Randel, J.M., Morris, B.A., Wetzell, C.D., & Whitehill, B.V. (1992). The effectiveness of games for educational purposes: a review of recent research, *Simulation & Gaming*, 23 (3), 261-276
- Ravenscroft, A. (2007). Promoting thinking and conceptual change with digital dialogue games. *Journal of Computer Assisted Learning*, 23(6), 453-465.

- Rodrigues, M., & Carvalho, P. S. (2013). Teaching physics with *Angry Birds*: exploring the kinematics and dynamics of the game. *Physics Education*, 48(4), 431.
- Rohrer, D. (2002). Misconceptions about incline speed for nonlinear slopes. *Journal of Experimental Psychology: Human Perception and Performance*, 28, 963–973
- Sadler, T. D., Romine, W. L., Stuart, P. E., & Merle-Johnson, D. (2013). Game-based curricula in biology classes: Differential effects among varying academic levels. *Journal of Research in Science Teaching*, 50(4), 479-499.
- Sequeira, M., & Leite, L. (1991). Alternative conceptions and history of science in physics teacher education. *Science Education*, 75, 45–56
- Short, D. (2012). Teaching scientific concepts using a virtual world—Minecraft. *Teaching Science-the Journal of the Australian Science Teachers Association*, 58(3), 55.
- Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psychology*, 64(2), 489-528.
- Squire, K. (2003). Video games in education. *International Journal of Intelligent Games & Simulation*, 2(1), 49-62.
- Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T. (2004, June). Electromagnetism supercharged!: Learning physics with digital simulation games. In *Proceedings of the 6th international conference on Learning sciences* (pp. 513-520). International Society of the Learning Sciences.
- Sun, C. T., Ye, S. H., & Wang, Y. J. (2015). Effects of commercial videogames on cognitive elaboration of physical concepts. *Computers & Education*, 88, 169-181.
- Tanes, Z., & Cemalcilar, Z. (2010). Learning from SimCity: An empirical study of Turkish adolescents. *Journal of Adolescence*, 33(5), 731-739.
- Tasley, S. D. (1995). The role of talk in children's peer collaborations. *Developmental Psychology*, 31(2), 207.
- Tennyson, R. D., & Jorczak, R. L. (2008). A conceptual framework for the empirical study of instructional games. *Computer Games and Team and Individual Learning*, 3-20.
- Van Boxtel, C., Van der Linden, J., & Kanselaar, G. (2000). Collaborative learning tasks and the elaboration of conceptual knowledge. *Learning and Instruction*, 10(4), 311-330.
- Ventura, M., Hu, X., Nye, B. D., & Zhao, W. (2015). NewtonianTalk: Integration of Physics Playground and AutoTutor using GIFT. In *Workshop on Developing a Generalized Intelligent Framework for Tutoring (GIFT): Informing Design through a Community of Practice* (p. 23).
- Vicovaro, M. (2014). Intuitive physics of free fall: an information integration approach to the mass-speed belief. *Psicológica*, 35(3), 463-477.
- Wouters, P., Van Nimwegen, C., Van Oostendorp, H., & Van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249.
- Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., ... & Yukhymenko, M. (2012). Our princess is in another castle a review of trends in serious gaming for education. *Review of Educational Research*, 82(1), 61-89.

# **SECCIÓN IV**

---

## **DISCUSIÓN GENERAL**

### **Y**

## **CONCLUSIONES FINALES**

## CAPÍTULO 8. DISCUSIÓN GENERAL

---

### 8.1. Concepciones del profesorado e integración de las TIC en contextos educativos

#### *Estudio I: Clasificación y análisis de las creencias y usos de las TIC: Elaboración del FrameTEP*

Como ya he señalado anteriormente en varias ocasiones, la primera línea de trabajo explorada, apoyándonos en la idea ampliamente justificada de que las creencias epistemológicas y educativas tienen una influencia fundamental sobre la forma en la que posteriormente nos comportamos en contextos instruccionales (Golpnik y Melzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al., 2006), ha sido profundizar en *la relación que se establece entre las concepciones de los docentes y la forma en la que se apropian de las TIC como instrumentos educativos*.

Para ello, en primer lugar, y como parte de mi trabajo desarrollado en colaboración con la Dra. Sarah Prestridge durante mi estancia en Australia, revisamos en profundidad la literatura científica elaborada al respecto, contemplando y valorando las diferentes formas en las que se han operativizado algunos de los constructos más relevantes en este área, como son las creencias epistemológicas, las creencias pedagógicas, los enfoques pedagógicos, la competencia tecnológica y los niveles de aprendizaje.

Atendiendo a todos estos aspectos, ampliamente desarrollados en la literatura científica, nuestro objetivo fundamental en este primer trabajo (ver *Estudio I-Artículo I*) era sintetizar las contribuciones más relevantes en un instrumento de análisis y clasificación (denominado *FrameTEP*), integradora y holística, que nos permitiera interpretar cómo y por qué los profesores utilizan las TIC en contextos educativos de la forma en que lo hacen.

Para probar la funcionalidad de este instrumento analizamos tres casos particulares de profesores participantes en el Proyecto Serious Play (2012-2015), financiado por el Gobierno de Australia y del cual pude formar parte durante mi estancia breve realizada en el año 2013. Los resultados obtenidos, en la línea sugerida por numerosos autores (Ertmer et al., 2012; Kim et al., 2013; Kordaki, 2013), ponen de manifiesto las sinergias entre creencias y práctica. En aquél caso en el que la profesora concebía el conocimiento como una construcción conjunta donde el alumno debía participar activamente y asumir el control de su proceso de aprendizaje, el videojuego seleccionado y la forma de emplearlo fueron coherentes con estas creencias.

En el caso contrario, las creencias también parecían orientar el tipo de juego seleccionado y la forma de usarlo. Aquella profesora que concebía el conocimiento en términos de correcto o incorrecto, utilizó un videojuego donde se iban formulando a los estudiantes una serie de cuestiones que debían acertar. Es decir, en este caso las TIC funcionaban como cadena de transmisión del conocimiento considerado relevante.

El instrumento de análisis elaborado, el *FrameTEP*, nos ha permitido explicitar y tomar conciencia de las creencias del profesorado y uso de las TIC en contextos instruccionales específicos, lo que supone un paso previo e imprescindible para una verdadera transformación



de la práctica. No nos corresponde a nosotros, sino más bien a la comunidad científica, juzgar la utilidad y relevancia del esfuerzo llevado a cabo.

### *Estudio II: Clasificación y análisis de las creencias y usos de las TIC: Elaboración de un Sistema Categorical*

Si bien es cierto que en este primer trabajo las creencias del profesorado sirvieron como guía a la hora de seleccionar e implementar las TIC en el aula, estos resultados no se vieron apoyados por los obtenidos en un segundo estudio, donde nuestra aproximación fue desde una mirada mucho más analítica, atendiendo a aspectos más concretos que en el caso anterior (ver *Estudio II-Artículo II*).

Basándonos en investigaciones previas llevadas a cabo por nuestro equipo en otras áreas (Casas, Montero y Pozo, 2015; López-Iñíguez y Pozo, 2016; Pozo y Postigo, 2000), aplicamos el modelo de Resultados, Procesos y Condiciones de Aprendizaje para el análisis de las relaciones que se establecen entre las concepciones del profesorado y el uso educativo que hacen de las TIC a una muestra de profesores de primaria. Lo más relevante de los resultados obtenidos, además del diseño del Sistema Categorical para el análisis de las creencias y usos de las TIC, es la brecha que encontramos entre las concepciones y los usos: mientras que las primeras, de forma generalizada, parecían responder a una epistemología más constructivista, los usos se ajustaban en mayor medida a mecanismos de transmisión de las voces autorizadas.

A pesar de lo sorprendente de este resultado, no es la primera vez que se informa de estas contradicciones. Liu (2011), en una muestra de 1139 profesores de educación primaria, encontró resultados similares: aunque la mayoría de los profesores se identificaban con creencias coherentes con principios constructivistas, su práctica educativa se aproximaba en mayor medida a enfoques más tradicionales.

Transformar la práctica necesariamente exige adoptar una actitud epistémica (Kirsh y Maglio, 1994; Pozo, 2008, 2014), es decir, entender las TIC como instrumentos no para apropiarse de un objeto concreto de conocimiento, sino como instrumento de mediación del pensamiento. Ese salto cualitativo en el que las TIC dejan de ser complemento de la actividad para convertirse en prótesis cognitiva necesariamente pasa por un proceso de explicitación (Dienes y Perner, 1999), de toma de conciencia, que supone el paso previo para el cambio de las concepciones.

Sin embargo, tal y cómo parecen indicar trabajos como el de Liu (2011) o el *Artículo II* de esta tesis doctoral (de Aldama y Pozo, 2016), las concepciones y creencias del profesorado, aun siendo factores necesarios para la transformación de la práctica, no son factores suficientes. Se puede ser consciente de las posibilidades de las TIC, como en el caso de nuestros profesores del *Artículo II*, y sin embargo no saber, no poder o no querer ponerlas en acción. Para lograrlo, entre otras cosas, es necesario contar con ejemplos a partir de los cuales extraer claves para su integración efectiva en contextos educativos. Ese ha sido el objetivo de la segunda línea de acción de esta tesis doctoral, la del *análisis de la práctica*, que a continuación paso a discutir.

## 8.2. Análisis de la práctica e integración de las TIC en contextos educativos

En relación con la segunda línea de trabajo explorada en esta tesis doctoral, la que tiene que ver con el *análisis de la práctica*, son varios los resultados que se deben comentar. En primer lugar me centraré en aquéllos obtenidos en el Estudio III a partir del cual se derivan los Artículos III y IV.

### *Estudio III: Integración de las TIC en el aula: Un Estudio de Caso*

Como ya he señalado anteriormente, se trata de un trabajo cuyo objetivo fundamental ha sido *aportar evidencia empírica en cuanto a las relaciones que se dan, en un entorno abierto y complejo mediado por las TIC, entre los elementos más relevantes en todo contexto formal de enseñanza y aprendizaje, es decir, profesor, alumnos y contenidos*.

Los resultados obtenidos del estudio de caso analizado revelaron al menos dos aspectos relevantes. En primer lugar, se observó que en aquellos casos donde el contenido de aprendizaje era más abierto y complejo, las interacciones entre el profesor y los alumnos fueron de mayor riqueza. En otras palabras, cuando las actividades desarrolladas en el aula permitían múltiples recorridos y soluciones, los alumnos se formulaban cuestiones de mayor complejidad que en el caso en el que las actividades estaban más acotadas y la solución para resolverlas mejor definida. Del mismo modo, la reflexión conjunta desarrollada entre profesor y alumnos era más elaborada cuando las actividades permitían múltiples opciones.

Sin embargo, en la mayoría de los casos, las actividades escogidas por los alumnos correspondían a tareas de contenido específico (el 49% de las actividades escogidas, ver Tabla 7.1.3), cuya solución dependía en muchos casos de la adquisición de datos e información concreta y específica. A pesar de esta realidad, el segundo de los aspectos relevantes de este trabajo fue la capacidad del docente para redefinir la pregunta del alumno en otra más compleja. La práctica docente, guiada por una meta epistémica (Kirsh y Maglio, 1994), aprovechaba las cuestiones y dudas del alumno, a menudo muy apegadas al contenido concreto de la actividad, como punto de partida para una reflexión posterior más elaborada. Como consecuencia, la interacción entre el docente y los alumnos finalizaba en muchos casos con estos últimos formulándose nuevas preguntas más allá de las respuestas inicialmente buscadas

En este contexto, las TIC servían como posibilidad para acceder a las múltiples voces que pueblan la red. Pero el diálogo con ellas, como ya señalé anteriormente, no emerge de forma espontánea (Coll y Monereo, 2008; Pozo, 2008, 2014; Voogt y Knezek, 2008). Surge, en términos de Dienes y Perner (1999), al adoptar una actitud epistémica donde explicitamos nuestra relación con respecto al objeto. En otras palabras, dialogar con esas voces significa cuestionarlas, reconocer sus intenciones e intereses y tomar conciencia de nuestra posición con respecto a ellas. En ese camino, que no es otro que el de la *alfabetización informacional*, el docente tiene la imprescindible función, como pone de manifiesto nuestro trabajo, de ceder temporalmente a sus alumnos parte de su conciencia hasta que se apropien de esa actitud epistémica.

### *Estudio IV: Aprendizaje de conceptos sobre el movimiento de los objetos a través del uso (epistémico) del Angry Birds*

Si bien es cierto que en el análisis de la práctica del trabajo anterior las TIC fundamentalmente permitían el acceso a la multiplicidad de voces que pueblan la red, en este segundo trabajo, del cual se deriva el *Artículo V*, las TIC son esencialmente utilizadas como instrumento de representación.

Como ya adelantamos anteriormente, llevamos a cabo un cuasi experimento en diferentes aulas de educación secundaria con el objetivo de evaluar en qué medida distintas formas de jugar al conocido videojuego Angry Birds permitía o no el aprendizaje de ciertos conceptos relacionados con el movimiento de objetos y el tiro parabólico. Los resultados hallados revelaron varios aspectos interesantes. En primer lugar, el simple hecho de jugar al videojuego no aportó aprendizajes significativos. En términos de Kirsh y Maglio (1994), cuando los estudiantes utilizaron el Angry Birds guiados por metas pragmáticas, es decir, con el objetivo único de pasar pantalla tras pantalla, no aprendieron ningún aspecto relevante con respecto a la física del movimiento de los objetos.

Sin embargo, cuando su práctica estuvo guiada por metas epistémicas, es decir, por preguntas orientadas a la comprensión de las reglas de la física que subyacen al universo del Angry Birds, los resultados fueron diferentes. En ese caso los estudiantes fueron capaces de reconocer más variables, elaborar mejores explicaciones y comprender mejor la relación entre el ángulo y la distancia en el movimiento de los objetos.

Angry Birds configuraba un escenario privilegiado a partir del cual los alumnos podían desarrollar representaciones conceptuales de fenómenos tradicionalmente explicados a través de formulaciones abstractas (Anderson y Barnett, 2011). Desde el punto de vista del *embodied cognition*, el Angry Birds permitía la experiencia perceptiva necesaria para el desarrollo de esas representaciones. En otras palabras, para comprender la formulación abstracta del movimiento de los objetos, alejada de nuestra experiencia cotidiana, necesitamos partir de la información que nos atraviesa corporalmente a través de nuestros sentidos. El escenario que configura el Angry Birds ofrecía ese punto de partida.

Sin embargo, el videojuego no está diseñado de tal forma que se conecte directamente el conocimiento implícito sobre el movimiento de los objetos y su formulación abstracta. Por ese motivo los alumnos que jugaron al Angry Birds simplemente por diversión no aprendieron conceptos sobre la física del movimiento de los objetos, por lo menos desde el punto de vista de su formulación matemática.

Tanto en el ejemplo anterior sobre el análisis de la práctica como en este último trabajo sobre el uso del Angry Birds, las TIC sirvieron como contexto a partir del cual se desplegaron acciones muy diferentes. Lo interesante, desde mi punto de vista, es que en ambos casos el valor pedagógico y transformador de estas herramientas se materializó cuando su uso respondía a intenciones educativas para nada implícitas. La mente virtual estratégica, en la que tanto he insistido a lo largo de esta tesis doctoral y como ponen de manifiesto alguno de los trabajos que he llevado a cabo, no emerge de la mera introducción de las TIC en el aula, sino de un uso estratégico y planificado. En la Tabla vi resumo los resultados obtenidos en la

Tesis Doctoral atendiendo a los Objetivos descritos anteriormente (ver SECCIÓN II-OBJETIVOS GENERALES).

**Tabla vi.** Resumen de los Resultados obtenidos en la Tesis Doctoral

OBJETIVO GENERAL	OBJETIVO ESPECÍFICO	ESTUDIOS EMPÍRICOS	PUBLICACIONES	RESUMEN OBJETIVOS	RESUMEN RESULTADOS
PROCESO DE INTEGRACIÓN EFECTIVA DE LAS TIC EN CONTEXTOS EDUCATIVOS	RELACIÓN ENTRE CONCEPCIONES Y USOS DE LAS TIC	ESTUDIO I	<b>Artículo I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	O1.1: Revisión constructos relevantes en relación con las creencias e integración de las TIC en contextos educativos: <ul style="list-style-type: none"> <li>✓ Creencias epistemológicas</li> <li>✓ Creencias pedagógicas</li> <li>✓ Enfoques pedagógicos</li> <li>✓ Competencia tecnológica</li> <li>✓ Niveles de aprendizaje</li> </ul> O1.2: Elaboración FrameTEP O1.3: Aplicación FrameTEP	R1.1: Organización teórica R1.2: Integración teórica R1.3: En los tres casos analizados, creencias y usos de las TIC fueron coherentes. Creencias transmisivas favorecían usos centrados en el contenido. Creencias constructivistas favorecían usos más complejos basados en una construcción conjunta del conocimiento
		ESTUDIO II	<b>Artículo II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286	O2.1: Elaboración Sistema Categorial para el Análisis de las Creencias y Usos de las TIC O2.2: Identificar creencias profesorado O2.3: Identificar prácticas educativas mediadas por TIC O2.4: Identificar algunas variables relevantes relacionadas con las creencias y los usos de las TIC	R2.1: Integración teórica R2.2: Creencias centradas en el alumno R2.3: Usos de las TIC centrados en el contenido y profesor. Es decir, existía una brecha entre concepciones y prácticas. R2.4: Profesores especialistas y de 2º y 3º ciclo de primaria mostraron usos más elaborados
	ANÁLISIS DE PRÁCTICAS MEDIADAS	ESTUDIO III	<b>Artículo III</b> de Aldama, C. & Pozo, J.I. (unpublished manuscript) ICT as teaching and learning tools at university: A case	O3: Aportar evidencia empírica en cuanto a la relación de los elementos del triángulo interactivo en un entorno complejo de aprendizaje mediado por TIC: O.3.1: Relación Contenido y Uso de las TIC	R3: El Contenido de Aprendizaje influye en gran medida en la calidad de la interacción entre docente y estudiantes. La calidad de la interacción

PROCESO DE INTEGRACIÓN EFECTIVA DE LAS TIC EN CONTEXTOS EDUCATIVOS (CONT.)	ANÁLISIS DE PRÁCTICAS MEDIADAS POR TIC (CONT.)	ESTUDIO III (CONT.)	study from a relational perspective	O.3.2: Relación Contenido-Alumno/s O.3.3: Relación Contenido-Profesor O.3.4: Relación Contenido-Estructura de participación	también depende de la capacidad del docente para redefinir las preguntas de los alumnos en otras más complejas R3.1: Contenidos más complejos favorecen usos de las TIC más complejos R.3.2: Contenidos más complejos favorecen que los alumnos se formulen preguntas más elaboradas R.3.3: Contenidos más complejos favorecen Ayudas pedagógicas por parte del docente más elaboradas R.3.4: Contenidos más complejos favorecen mejores estructuras de participación
			<b>Artículo IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd	O4: Describir principios básicos del <i>Análisis de Contenido</i> como método de investigación en Educación: O4.1: Relación enfoque teórico-preguntas de investigación-análisis de contenido O4.2: Procedimiento para el desarrollo de categorías de análisis: <i>feed-back looping process</i> O4.3: Elaboración de reglas de codificación específicas	R4: Elaboración de un material útil para aplicar el <i>Análisis de Contenido</i> como método de investigación en Educación

		ESTUDIO IV	<p><b>Artículo V</b> de Aldama, C. &amp; Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool</p>	<p>O5.1: Aportar evidencia empírica en cuanto al aprendizaje de conceptos sobre el movimiento de objetos, fruto del uso pragmático y epistémico del Angry Birds</p> <p>O5.2: Efecto del uso del Angry Birds sobre “creencias ingenuas” en relación con el movimiento de objetos (p.ej: “speed-mass belief”)</p> <p>O5.3: Efecto sobre el aprendizaje del uso individual o por parejas del Angry Birds</p>	<p>R5.1: El mero hecho de jugar al <i>Angry Birds</i> no produce aprendizaje significativo. El aprendizaje se produce cuando la práctica es guiada por metas epistémicas</p> <p>R5.2: El uso del Angry Birds no tuvo efecto sobre “creencias ingenuas” como el efecto de la masa en la caída libre de objetos</p> <p>R5.3: No hubo diferencias significativas entre los que jugaron individualmente o por parejas</p>
--	--	------------	--	---	---

## Limitaciones y líneas futuras de investigación

Un trabajo de esta magnitud, cuya duración ha sido aproximadamente de cinco años, inevitablemente contiene limitaciones importantes y aspectos que posiblemente podrían mejorarse. Trazar un camino supone tomar decisiones asumiendo sus consecuencias y riesgos.

La primera de las limitaciones que debo comentar es precisamente la fragmentación, en algunos casos, del trabajo realizado. Desde mi punto de vista han sido demasiados los frentes que hemos tratado de abordar, y eso tiene consecuencias en el producto final elaborado. A pesar del importante esfuerzo llevado a cabo por desarrollar un hilo argumental sólido y bien estructurado, es evidente que existen fricciones y aspectos que podrían haberse mejorado.

En primer lugar decidimos profundizar en la relación entre las concepciones del profesorado y el uso de las TIC. Si bien es cierto que hemos obtenido resultados interesantes y que hemos ayudado al crecimiento, tanto teórico como empírico, en esta área, nuestra aproximación se ha reducido a un plano descriptivo. Es decir, nos limitamos a elaborar dos herramientas de clasificación y análisis (FrameTEP y el Sistema Categorical para el análisis de las creencias y usos de las TIC) y a probar su funcionalidad con dos muestras específicas. Estos trabajos no tuvieron continuidad en otros donde pudiéramos intervenir directamente sobre las creencias y los usos.

En su lugar, decidimos analizar prácticas educativas mediadas por TIC, muy diversas entre sí. En la primera observamos un contexto natural complejo donde las TIC funcionaban fundamentalmente como entorno de acceso, búsqueda, gestión y comunicación de la información. En el segundo, un entorno mucho más controlado, decidimos intervenir sobre las diferentes condiciones en el uso del videojuego Angry Birds, donde las TIC jugaban un papel fundamentalmente representacional.

Ambos trabajos pertenecen a líneas de investigación y marcos teóricos muy diferentes. Los videojuegos como instrumentos de aprendizaje, los serious games y “Games Based Learning (GBL)”, aun configurando un subconjunto de las TIC, representan un espacio de investigación con sus propiedades específicas.

Sin duda, y sin que esta afirmación sirva como excusa, haber investigado un terreno como el de las TIC y su integración en contextos educativos, por definición en continuo cambio y transformación, no ha favorecido una aproximación estable y perfectamente articulada.

Un segundo aspecto que desde mi punto de vista debe ser objeto de reflexión es la propia diada concepción-práctica que desde el comienzo de este trabajo establecimos como *a priori*. Resultados como el de Liu (2011), de los que ya hemos hablado anteriormente, los de Teo, Chai, Hung y Lee (2008) donde encontraron una correlación positiva entre creencias constructivistas y prácticas tanto constructivistas como más tradicionales, o los de nuestro propio trabajo (de Aldama y Pozo, 2016), revelan que las concepciones no son un factor suficiente como para explicar la integración efectiva de las TIC en contextos educativos. Algunos autores consideran las concepciones una suerte de ZDP de la práctica, es decir, una



condición, que sin llegar a garantizar la transformación de la acción educativa, es requisito indispensable para su posible articulación (Torrado y Pozo, 2006).

Si queremos realmente que las TIC lleguen a implementarse algún día de forma generalizada aprovechando sus potencialidades educativas, debemos ampliar el foco de análisis y contemplar otros factores. Algunos de ellos, ya adelantados por otros autores, también pueden localizarse en el propio profesorado, como puede ser su falta de competencia tecnológica (Teo, 2009) o la falta de tiempo por la presión de un currículo sobrecargado (Wepner, Ziomek, y Tao, 2003). Otros pueden encontrarse en niveles de análisis diferentes, como el impulso de políticas educativas eficientes (Albion, Forkosh-Baruch y Tondeur, 2013), creación de comunidades de práctica (Albion, Tondeur, Forkosh-Baruch y Peeraer, 2015) o el liderazgo de los equipos directivos (Enguita, 2014).

Otro aspecto sobre el que también considero que es importante reflexionar es el propio enfoque teórico desde el que nos hemos aproximado. Aunque explícitamente he defendido al comienzo del documento que una integración efectiva de las TIC es aquella que favorece el desarrollo integral de las personas, implícitamente se ha operativizado como aquella que permite una mejor gestión de la información y el conocimiento (*Estudio III*), así como el desarrollo y elaboración de representaciones conceptuales más complejas (*Estudio IV*). Un enfoque de estas características, heredero de una tradición marcadamente cognitivista, dibuja a mi modo de entender un escenario incompleto. Por ejemplo, sin entrar a profundizar demasiado, nada he dicho a lo largo de mi trabajo acerca de cómo el uso de las TIC nos afecta emocionalmente y de cómo podríamos desarrollar una mente virtual estratégica en relación con esta dimensión<sup>1</sup>.

Otro aspecto que también me parece honesto señalar tiene que ver con algunas decisiones metodológicas adoptadas. Desde mi punto de vista, creo que hemos sido capaces de integrar razonablemente bien tradiciones metodológicas en ocasiones enfrentadas, como son una visión más cualitativa y otra más cuantitativa de los fenómenos educativos analizados. Incluso uno de los trabajos elaborados, del que se deriva el *Artículo IV*, es un desarrollo teórico sobre el Análisis de Contenido como metodología válida para la investigación educativa. Esta realidad, lejos de ser un problema, creo que ha enriquecido la tesis doctoral y mi experiencia como investigador.

Ahora bien, adoptar esta mirada mixta en ocasiones ha provocado ciertas dificultades. Por ejemplo, en el *Artículo II* planteamos un análisis cuantitativo con una muestra reducida de 16 profesores. Un tamaño muestral tan pequeño nos obligó a emplear análisis estadísticos no paramétricos, lo que sin duda tuvo consecuencias sobre la calidad de los resultados

---

<sup>1</sup> El lector interesado puede revisar el interesante trabajo de Joan Ferrés i Prats (2014), titulado “Las pantallas y el cerebro emocional”, donde entre otras cosas el autor advierte de los riesgos que corremos cuando no tomamos conciencia de cómo las TIC y los contenidos que vehiculan en muchos casos se dirigen directamente a nuestras emociones más primarias.

obtenidos<sup>2</sup>. La evidencia empírica que se derivó de este trabajo debía ser por lo tanto interpretada con precaución.

Por otro lado, en el estudio de caso, del cual se derivan los *Artículos III y IV*, planteamos un análisis micro-analítico con una mirada completamente cuantitativa. Mi sensación personal al respecto es que esa aproximación, en este caso en concreto, implicaba renunciar a otras dimensiones relevantes que emergían en planos diferentes. León y Montero (2015) lo expresan de forma brillante cuando afirman que:

(en el análisis de datos cualitativos) se hace necesario mantener el lenguaje natural como código en el que se procesan los datos-en eso consiste el análisis cualitativo de datos-porque así cada participante podrá expresar su propia visión subjetiva sin ser forzado a utilizar las categorías de análisis del investigador, ni ser diluido en una medida-el estadístico-que, muy a menudo, es un mal resumen de cosas cualitativamente diferentes (p.452).

Dicho de otra forma, nuestras categorías de análisis, refinadas a lo largo del proceso hasta convertirse en herramientas útiles, fueron desde mi punto de vista un obstáculo para extraer otro tipo de información relevante<sup>3</sup>.

Atendiendo a las limitaciones descritas previamente, existen varias líneas futuras de investigación posibles. En primer lugar, se podría profundizar en la relación entre creencias y usos de las TIC explorando diferentes dimensiones. Sería interesante analizar empíricamente cómo se originan estas creencias, así como el proceso de co-evolución entre ambos factores. El diseño de un programa de intervención donde se contemplaran diferentes condiciones en los usos de las TIC podría dar algunas claves al respecto.

Otra línea futura de investigación sería ampliar el espectro de análisis. Como ya he señalado en varias ocasiones, las creencias, aun siendo un factor necesario para la transformación de la práctica, no es suficiente para explicarlo. Se deben explorar otros niveles tanto macro (p.ej. políticas educativas) como micro (p.ej. competencia tecnológica o necesidades del profesorado).

Aproximarnos al proceso de integración de las TIC desde otros enfoques teóricos también podrían ser líneas de investigación interesantes. Otros marcos conceptuales más holísticos (p.ej. de corte más socioconstructivista como la Teoría de la Actividad o el Conectivismo) podrían contribuir de forma cualitativamente diferente al aumento del conocimiento en este área, así como poner el acento en otras dimensiones igualmente relevantes (p.ej. dimensión emocional).

Por último, también sería interesante explorar aproximaciones metodológicas diferentes que permitieran extraer otro tipo de información relevante sobre el proceso de integración de las TIC en contextos educativos. Como señalaran León y Ruiz-Hernando (2010),

---

<sup>2</sup> El lector interesado puede revisar la obra de Field (2013) para profundizar en el poder estadístico (es decir, la capacidad de una prueba para detectar efectos que realmente existen) de las pruebas no paramétricas.

<sup>3</sup> Haciendo uso de la sabiduría popular, en este caso “los árboles no dejaron ver el bosque” (se puede consultar en <http://cvc.cervantes.es/lengua/refranero/Ficha.aspx?Par=58990&Lng=0>)

la forma de preguntar (y de mirar) afecta directamente a la naturaleza de las respuestas encontradas. La Tabla vii resume las limitaciones de esta tesis doctoral, así como las posibles líneas futuras de investigación.

**Tabla vii.** *Limitaciones y Líneas Futuras de Investigación*

Limitaciones de la Tesis Doctoral	Líneas futuras de investigación
Análisis descriptivo de la relación entre creencias y usos de las TIC	Explorar otras dimensiones de esta relación (p.ej. génesis y co-evolución)
Foco de investigación centrado en la relación entre creencias y usos	Ampliar el espectro de análisis, contemplando otras dimensiones macro (p.ej políticas educativas) y micro (competencia tecnológica y necesidades del profesorado)
Enfoque teórico	Contemplar otras dimensiones del proceso de integración de las TIC (p ej. dimensión emocional), así como la aproximación teórica (p ej. desde un enfoque socioconstructivista)
Enfoque metodológico	Explorar otras posibles aproximaciones metodológicas

## Referencias

- Albion, P., Forkosh-Baruch, A., y Tondeur, J. (2013). *Working Group 3: Summary Report and Action Agenda*.
- Albion, P. R., Tondeur, J., Forkosh-Baruch, A., y Peeraer, J. (2015). Teachers' professional development for ICT integration: towards a reciprocal relationship between research and practice. *Education and Information Technologies*, 20(4), 655-673.
- de Aldama, C. y Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, *Electronic Journal of Research in Educational Psychology*
- Anderson, J., & Barnett, M. (2011). Using videogames to support pre-service elementary teachers learning of basic physics principles. *Journal of Science Education and Technology*, 20(4), 347-362.
- Casas-Mas, A., Montero, I. y Pozo, J.I. (2015). El discurso sobre la práctica de un guitarrista de jazz semi-profesional: Estudio de caso de aprendizaje musical constructivo. *International Association for the Study of Popular Music Journal*, 5 (1) [http://www.iaspmjournal.net/index.php/IASPM\\_Journal/article/view/722](http://www.iaspmjournal.net/index.php/IASPM_Journal/article/view/722)  
doi: 10.5429/2079-3871(2015)v5i1.5es
- Coll, C., y Monereo, C. (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Dienes, Z., y Perner, J. (1999) A theory of implicit and explicit knowledge. *Behavioural and Brain Sciences*, 22, 735-755.
- Enguita, M.F. (2014). Contra todo pronóstico. En *MECD (2014) Informe español TALIS 2013: Estudio Internacional de la enseñanza y el aprendizaje. Análisis secundario*. Disponible en [https://www.oecd.org/edu/.../Spain-TALIS-2013-secundarioweb%201-10-2014\\_es.pdf](https://www.oecd.org/edu/.../Spain-TALIS-2013-secundarioweb%201-10-2014_es.pdf), consultado el 23 de Noviembre de 2015.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., y Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers &*

- Education*, 59(2), 423-435. Gopnik, A., & Melzoff, A. N. (1997). Words, thoughts and theories. Cambridge, MA: MIT Press.
- Ferrés, J. (2014). *Las pantallas y el cerebro emocional*. Barcelona: Editorial Gedisa.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London: Sage.
- Kim, C., Kim, M. K., Lee, C., Spector, J. M., y DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76-85.
- Kirsh, D., y Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive Science*, 18(4), 513-549.
- Kordaki, M. (2013). High school computing teachers' beliefs and practices: A case study. *Computers & Education*, 68, 141-152.
- León, O. y Ruiz-Hernando, N. (2010). *Cómo afecta la forma de preguntar a los participantes. ¿Tiene sentido hablar del principio de indeterminación en Ciencias Sociales?* Documento no publicado. Universidad Autónoma de Madrid
- Liu, S. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers and Education*, 56, 1012-1022. doi:10.1016/j.compedu.2010.12.001
- López-Íñiguez, G. y Pozo, J.I. (2016) Analysis of constructive practice in instrumental music education: Case study with an expert cello teacher, *Teaching and Teacher Education*, 60, 97-107.
- Pérez-Echeverría, M. P., Mateos, M., Pozo, J. I., y Scheuer, N. (2001). En busca del constructivismo perdido: concepciones implícitas sobre el aprendizaje. *Estudios de psicología*, 22(2), 155-173.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J. I. (2014). *Psicología del Aprendizaje Humano: Adquisición de conocimiento y cambio personal*. Madrid: Morata.
- Pozo, J.I. y Postigo, Y. (2000). *Los procedimientos como contenidos escolares*. Barcelona: Edebé
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., y de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.
- Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*. 52: 302-312.
- Teo, T., Chai, C. S., Hung, D., y Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education*, 36(2), 163-174.
- Torrado, J.A. y Pozo, J.I. (2006). Del dicho al hecho. De las concepciones sobre el aprendizaje a la práctica de la enseñanza de la música. En J.I. Pozo, N.Scheuer, M. del P. Pérez Echeverría, M. Mateos, E. Martín, y M. de la Cruz (Eds.), *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*, (pp.205-230) Barcelona: Graó.
- Voogt, J., y Knezek, G. (Eds.). (2008). *International handbook of information technology in primary and secondary education* (Vol. 20). Springer Science & Business Media.
- Wepner, S. B., Ziomek, N., y Tao L. (2003). Three teacher educators' perspectives about the shifting responsibilities of infusing technology into the curriculum. *Action in Teacher Education*, 24(4), 53-63.

## CHAPTER 8. GENERAL DISCUSSION

---

### 8.1. Teachers' beliefs and integration of ICT in educational contexts

#### *Study I: Classification and analysis of beliefs and uses of ICT: Elaboration of FrameTEP*

As I already mentioned, the first research line explored, based on the idea that epistemological and educational beliefs have an essential influence over our behavior in instructional contexts (Golpnik & Melzoff, 1997; Pérez-Echeverría et al., 2001; Pozo et al. 2006), has been to *deeply explore the relationship between teachers' beliefs and how they use ICT as learning tools*. In collaboration with Dr. Sarah Prestridge, we first reviewed the scientific literature, taking into account the most relevant constructs such as epistemological and educational beliefs, pedagogical approaches, levels of learning or technology competency.

Attending all these aspects, the main aim of the first work (*see Study I-Manuscript I*) was to synthesize the most important contributions to develop a holistic and integrative instrument of analysis and classification (called FrameTEP). This tool would let us interpret how and why teachers use ICT in educational contexts in the way that they actually use them.

To prove the functionality of the FrameTEP we analysed three cases, corresponding to three teachers that participated in the Serious Play Project (2012-2015), funded by the Australian Government. As in previous research (Ertmer et al., 2012; Kim, et al., 2013; Kordaki 2013), results showed the synergy between beliefs and practice. In the case in which the teacher perceived knowledge as collective construction through the active participation of the students, the videogame chosen and the way they used it were coherent with those beliefs.

In the opposite case, beliefs also seemed to guide the selection of the videogame and how to use it. The teacher who perceived knowledge in terms of "true or false" used a videogame in which students had to provide the right answer. In other words, in this case the videogame was utilized like transmission of true knowledge.

FrameTEP has allowed us to make explicit and to be aware of teachers' beliefs and uses of ICT in educational contexts, which means the first step for a truly transformation of the practice. The scientific community will judge the relevance of this contribution.

#### *Study II: Classification and analysis of beliefs and uses of ICT: Elaboration of Categorical System*

Although in the first work teachers' beliefs seemed to guide how to implement ICT in their classrooms, this finding was not supported by the results obtained in the second study, that followed a more analytic approach (*see Study II- Manuscript II*).

Based on previous research conducted by our research team in other areas (Casas, Montero & Pozo, 2015; López-Iñíguez & Pozo, 2016; Pozo & Postigo, 2000), we applied the Results, Processes and Conditions of Learning Model to analyze the relationship between beliefs and uses of ICT with a sample of teachers from primary education. The most interesting contribution, besides developing a Categorical System of Analysis, was the gap found between

beliefs and practice. While the former seemed to be next to a constructivist epistemology, the latter fit better in a traditional approach.

Despite the contradiction, others authors have reported similar results. Liu (2011) found, in a sample of 1139 teachers from primary education, that most of them held constructivist beliefs, while their practice responded to traditional approaches.

An epistemic attitude is essential to transform the practice (Kirsh & Maglio, 1994; Pozo, 2008, 2014). That is, it is necessary to perceive ICT as instruments of thinking mediation instead of just instruments of transmission of knowledge. In order to achieve this, it is necessary to make explicit our own beliefs before changing them (Dienes & Perner, 1999).

However, based on studies such as Liu (2011) or de Aldama & Pozo (2016) teachers' beliefs are necessary but not sufficient factors to transform practice. Teachers can be aware of the educational possibilities of ICT (see *Manuscript II*), and, at the same time, do not know, want or be able to put them in action. In doing so, to provide good examples of effective integration of ICT in educational contexts can be a proper starting point. This has been the main aim of the second line's action of this doctoral dissertation. I will discuss about this topic in the following section.

## **8.2. Analysis of practice and integration of ICT in educational contexts**

### *Study III: Integration of ICT in classroom: a case study*

As I already pointed out before, the aim of this study has been to provide empirical evidence about the relationship between the three main components in any teaching and learning context (i.e. teacher, students and learning content known as "*interactive triangle*") in which actions were mediated by ICT.

The results revealed at least two interesting aspects. First of all, in those cases in which the learning content was more open and complex, the interactions between the teacher and their student were more elaborated. In other words, when developed activities let multiple solutions, students formulated more complex questions. Therefore, the joint reflection between the teacher and their students was more fruitful in these cases.

However, most of the times, students chose specific content activities (49%, see Table 7.1.3.), meaning closed activities with few solutions. Despite this fact, the second relevant aspect was the teacher's capability to redefine the students' questions in others which turned more complex. The teacher's practice, guided by epistemic goals (Kirsh y Maglio, 1994), used students' questions (which were shallow in many cases) as the starting point for future more elaborated joint reflection. As a consequence, in many cases, students ended the interaction with the teacher with more questions than answers.

In this context, ICT allowed students to access the multiple voices existing on the internet. However, the dialogue with these voices is not just a matter of introducing the ICT in the classroom (Coll & Monereo, 2008; Pozo, 2008, 2014; Voogt & Knezek, 2008). In terms of Dienes and Perner (1999), the dialogue emerges when we adopt an epistemic attitude. That is, expliciting our position is related to the object of knowledge. In other words, it means to

recognize our and the other's intentions and interests. To do this, teachers have the key function to lend part of their consciousness to their students until they internalize such attitude.

*Study IV: Learning concepts about object motion through the (epistemic) use of Angry Birds*

In this second work related with the analysis of practice (see Manuscript V) we conducted a quasi-experiment in order to assess how different uses of the well-known videogame *Angry Birds* involved different ways of learning conceptual knowledge related to projectile motion. The findings showed some interesting aspects that we summarize below.

First of all, the mere fact of playing *Angry Birds* did not imply learning more formal aspects underlying objects motion. In terms of Kirsh and Maglio (1994), when students used *Angry Birds* guided by pragmatic goals, namely when the aim was to overcome the different levels of the game, they did not learn meaningful concepts.

At the same time, when the students' practice was guided by epistemic goals (that is, by questions oriented to understand the physics laws underlying the universe of *Angry Birds*) then results were different. In this case, the students were able to recognize more variables, develop better explanations and better comprehension about the relationship between angle and distance.

The *Angry Birds* offered a privilege scenario from which students could develop conceptual representations of phenomena that is traditionally explained by abstract formulations (Anderson & Barnett, 2011). From the *embodied cognition* point of view, *Angry Birds* provided the necessary perceptive experience to develop those representations. In other words, to comprehend the abstract formulations of object motions, far from our daily experience, it seems to be necessary to start from the information we perceive through our sense. *Angry Birds* provides this starting point.

However, the videogame's design does not directly link implicit knowledge of object motion and its abstract formulation. For this reason, students who played just for fun did not learn formal concepts about physics.

In this study, as in the previous one, ICT were the context from which students could perform different actions. In my opinion, the most interesting thing was that, in both cases, the transformative and pedagogic value of ICT was materialized when they were used under reflected and explicit criteria. The strategic virtual mind, as I have mentioned before in this doctoral dissertation, does not emerge just when we introduce ICT in classrooms. It emerges when it follows a plan and a well-designed strategy. Table viii summaries the results obtained in this thesis attending to the aims described before (see SECTION II-GENERAL AIMS).

**Table viii**

*Summary of the Results obtained in this doctoral dissertation*

GENERAL AIM	ESPECIFIC AIM	EMPIRICAL STUDIES	MANUSCRIPTS	SUMMARY OF AIMS	SUMMARY OF RESULTS
ICT INTEGRATION IN EDUCATIONAL CONTEXTS	RELATIONSHIP BETWEEN BELIEFS AND USES OF ICT	STUDY I	<b>Manuscript I</b> Prestridge, S. & de Aldama, C. (2016). A classification framework for exploring technology enabled practice, <i>Journal of Educational Computing Research</i> , 1-21 DOI: 10.1177/0735633116636767	A1.1: Review of relevant constructs related with beliefs and integration of ICT in educational contexts: ✓ Epistemological beliefs ✓ Pedagogical beliefs ✓ Pedagogical approaches ✓ Technology competency ✓ Levels of learning A1.2: Elaboration of <i>FrameTEP</i> A.3: Application of <i>FrameTEP</i>	R1.1: Theoretical organization R1.2: Theoretical integration R1.3: In the three cases analysed, beliefs and uses were coherent. Traditional beliefs supported content-centred uses of ICT. Constructivist beliefs supported uses of ICT more complex based on joint construction of knowledge.
		STUDY II	<b>Manuscript II</b> de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, <i>Electronic Journal of Research in Educational Psychology</i> , 14 (2), 253-286	A2.1: Elaboration of Categorical System for Analysis of Beliefs and Uses of ICT A2.2: Identify teachers' beliefs A2.3: Identify teachers' practices mediated by ICT A2.4: Identify some key variables related with beliefs and uses of ICT	R2.1: Theoretical integration R2.2: Student-centred beliefs R2.3: Content and teacher-centred uses of ICT. In other words, there was a gap between beliefs and uses. R2.4: Specialist and 2 <sup>nd</sup> and 3 <sup>rd</sup> cycle of primary teachers showed more sophisticated uses.
	ANALYSIS OF PRACTICE MEDIATED BY ICT	STUDY III	<b>Manuscript III</b> de Aldama, C. & Pozo, J.I. (unpublished manuscript) ICT as teaching and learning tools at university: A case study from a relational perspective	A3: Provide empirical evidence about the relationship between <i>interactive triangle</i> when their actions are mediated by ICT A.3.1: Relationship Learning Content-Uses of ICT A.3.2: Relationship Learning Content-Student/s A.3.3: Relationship Learning Content-	R3: The Learning Content had large influence over the quality of interactions between teacher and students. The quality of interactions also depended on the teacher's capability to redefine students' questions in others more complex. 201



ICT INTEGRATION IN EDUCATIONAL CONTEXTS (CONT.)	ANALYSIS OF PRACTICE MEDIATED BY ICT (CONT.)			Teacher A.3.4: Relationship Learning Content- Structure of Participation	R3.1: More complex Learning Content favored more complex uses of ICT R.3.2: More complex Learning Content favored more elaborated students' questions. R.3.3: More complex Learning Content favored better teacher's Pedagogical Support R.3.4: More complex Learning Content favored better Structures of Participation
			<b>Manuscript IV</b> de Aldama, C., Pérez-García, D. & Pozo, J.I. (in press). Analysis of content: ICT Integration in higher education. In <i>SAGE Research Methods Cases</i> . London, United Kingdom: SAGE Publications, Ltd	A4: Describe basic principles of <i>Content Analysis</i> as research method in education A4.1: Relationship between theoretical approach-research questions-content analysis A4.2: Procedure to develop categories of analysis: <i>feedback-looping process</i> A4.3: Elaboration of specific rules of codification	R4: Developing useful material to apply <i>Content Analysis</i> as research method in Education

		STUDY IV	<p><b>Manuscript V</b> de Aldama, C. &amp; Pozo, J.I. , Gómez-Crespo, M.A. (under revision). Do you want to learn physics? Angry Birds as epistemic tool</p>	<p>A5.1: Provide empirical evidence about pragmatic and epistemic use of Angry Birds and results of learning A5.2: Effect of Angry Bird use over naïve conceptions related with object motion (e.g. "<i>speed-mass belief</i>") A5.3: Effect of individual or per pairs use of Angry Birds over learning results</p>	<p>R5.1: The mere fact of playing Angry Birds did not produce meaningful learning. This was produced when practice was guided by epistemic goals. R5.2: Playing Angry Birds did not modify "naïve beliefs" such as the effect of mass in free fall objects R5.3: There were not statistically significant differences between those who played alone or per pairs.</p>
--	--	----------	--	--	--

## Limitations and future research lines

Five years of intense research have led to this doctoral dissertation. Although we have already highlighted the contributions and the strengths of this work, we would also like to present some of its limitations and, at the same time, to suggest some of the ways in which this research could be improved.

The first limitation I should highlight is precisely some fragmentation of the work done. We may have opened too many research lines which inevitably ended up making difficult the closure of the final developed product. Despite our efforts to follow a clear and structured text, one can still find some gaps that need connection.

At the beginning we decided to deeply explore the relationship between teachers' beliefs and uses of ICT as a key aspect to understand the integration process of these technologies as educational tools. Although we have obtained interesting results, both theoretical and empirical, our approach has been merely descriptive. Namely, we developed two instruments of analysis and classification (the FrameTEP and the Categorical System) and tested their functionality with two specific samples. These works did not led to new ones in which direct intervention in beliefs and uses could be developed.

Instead, we decided to analyze educational practices mediated by very different ICT. In the first one, we observed a natural complex context where ICT were fundamentally used to access, search, manage and communicate information. In the second one, carried out in a much more controlled environment, we decided to apply different conditions using Angry Birds, where ICT were used basically as representational instruments. Although we obtained interesting results, we are aware that these two pieces of work belong to distinct frameworks. Videogames as learning instruments and *serious games* represent different research fields, even though they are a subset of ICT.

A second aspect I would like to mention is the own object of study that we researched, namely the relationship between beliefs and uses of ICT. Authors such as Liu (2011) or Teo, Chai, Hung and Lee (2008) who found a positive correlation between constructivist beliefs and both traditional as constructivist uses of ICT, revealed that beliefs are not enough factors to explain the effective integration of ICT in educational contexts. If we really keen that someday ITC are generalized, taking advantage of their educational possibilities, we should wider the focus of analysis and, at the same time, take into account different variables. Some of these, already pointed out by other authors, are related to teachers, such as the lack of technology competency (Teo, 2009), or the lack of time as consequence of an overwhelmed curricula. Other ones can be located in different levels of analysis, such as educational policies (Albion, Forkosh-Baruch & Tondeur, 2013), community of practices (Albion, Tondeur, Forkosh-Baruch & Peeraer, 2015) or the leadership of schools' management team (Enguita, 2014).

Another dimension that I would like to point out is the theoretical approach that we have adopted in this research. Although at the beginning of the document we defined the effective integration of ICT as the one that promotes the whole developing of people, actually we just analyzed the uses of ICT based on management of information and knowledge (see Study III) and also as representational tools (see Study IV). In my opinion, such approach, heir

of the cognitivist tradition, draws an incomplete scenario. For example, we haven't explored neither how uses of ICT affect our emotions, nor how to develop a strategic virtual mind related to this dimension<sup>1</sup>.

Regarding methodological aspects, we have been able to integrate methodological traditions, sometimes confronted, such as quantitative and qualitative approaches. Furthermore, one of the works developed (see Manuscript IV) is a theoretical contribution about *Analysis of Content* as useful methodology for educational research. This reality, far from being a problem, has enriched this thesis and my own experience as a researcher.

However, this methodological combination sometimes involved certain difficulties. For instance, in *Manuscript II* we developed a quantitative analysis with a reduced sample of 16 teachers. This small sample size forced us to conduct non-parametric statistical analysis, which negatively affected the quality of the results obtained<sup>2</sup>. Thus, the empirical evidence should be interpreted with caution.

Furthermore, in the case study conducted (see *Manuscript III* and *IV*) we developed a micro-analysis from a quantitative point of view. My personal feeling in this case was that this approach implied to renounce to other relevant dimensions that emerged in another levels of analysis. León & Montero (2015) explain it brilliantly when they claim:

(referring to qualitative data analysis) it's necessary to keep the natural language as code in which data is processed-that is qualitative data analysis-because thus each participant will be able to express his/her own point of view neither being forced to use categories of analysis from the researcher nor being diluted in a measure-the statistic-that in many cases are bad summary of things qualitatively different. (p.452 in the Spanish version).

In other words, our categories of analysis were useful to detect one kind of information but an added difficulty to identify other relevant aspects.

Attending the limitations described above, we consider that further research needs to be done. First of all, we could go further in the relationship between beliefs and educational uses of ICT, exploring different dimensions. It would be an important contribution to provide empirical evidence about the origin of beliefs, as well as the process of co-evolution of both factors. The design of an intervention program where the diverse conditions using ICT were controlled could provide some clues.

Another interesting research line would be to widen the focus of analysis. As I already pointed out, even though beliefs are necessary factors to transform practice they are not enough to explain it. Other levels of analysis, both macro (i.e. educational policy) and micro (i.e. teachers' technology competency or necessities) should be explored if we really want to understand the process of ICT integration.

---

<sup>1</sup> See the interesting work of Joan Ferrés I Prats (2014) entitled "Las pantallas y el cerebro emocional" where the author advises how ICT (and the content that they transmit) usually are designed to affect directly our emotions.

<sup>2</sup> See Field (2013) to deepen in the statistical power (i.e. the test's capability to detect effects that really exists) of non-parametric tests.

Different theoretical approaches also would help to increase the knowledge in this field. More holistic frameworks (i.e. closer to socioconstructivist views, such as Activity Theory or Conectivism) could illuminate another areas and develop new issues. If we look carefully at the ICT integration process, not just attending the more cognitivist dimensions of human being but also the rest of them (i.e. emotional dimension), we would be able to develop a better understanding of it.

Finally, it would be also interesting to complement our contributions from other methodological approaches. As León and Ruiz-Hernando (2010) claimed, how we asked (and look at) reality has direct implications in the nature of the answers found. Table ix summarizes the thesis' limitations and possible research future lines.

**Table ix.** Summary of thesis' limitations and possible future research lines

Thesis' Limitations	Future research lines
Descriptive analysis of the relationship between beliefs and uses of ICT	Explore other dimensions of this relationship (i.e. origin and co-evolution)
Research focuses on relationship between beliefs and uses of ICT	Get bigger the focus of analysis, taking account other macro and micro levels such as educational policy or teachers' technology competency
Theoretical approach	Complement our contributions from more holistic theoretical approaches (i.e. socioconstructivist) and explore other dimensions of the ICT integration process (i.e. emotional dimension)
Methodological approach	Explore other methodological approaches

## References

- Albion, P., Forkosh-Baruch, A., & Tondeur, J. (2013). *Working Group 3: Summary Report and Action Agenda*.
- Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: towards a reciprocal relationship between research and practice. *Education and Information Technologies*, 20(4), 655-673.
- de Aldama, C. & Pozo, J.I. (2016). How are ICT used in the classroom? A study of teacher's beliefs and uses, *Electronic Journal of Research in Educational Psychology*.
- Anderson, J., & Barnett, M. (2011). Using videogames to support pre-service elementary teachers learning of basic physics principles. *Journal of Science Education and Technology*, 20(4), 347-362.
- Casas-Mas, A., Montero, I. & Pozo, J.I. (2015). El discurso sobre la práctica de un guitarrista de jazz semi-profesional: Estudio de caso de aprendizaje musical constructivo. *International Association for the Study of Popular Music Journal*, 5 (1) [http://www.iaspmjournal.net/index.php/IASPM\\_Journal/article/view/722](http://www.iaspmjournal.net/index.php/IASPM_Journal/article/view/722)  
doi: 10.5429/2079-3871(2015)v5i1.5es
- Coll, C., & Monereo, C. (2008). *Psicología de la educación virtual*. Madrid: Morata.
- Dienes, Z., & Perner, J. (1999) A theory of implicit and explicit knowledge.

- Behavioural and Brain Sciences*, 22, 735-755.
- Enguita, M.F. (2014). Contra todo pronóstico. En *MECD (2014) Informe español TALIS 2013: Estudio Internacional de la enseñanza y el aprendizaje. Análisis secundario*. Disponible en [https://www.oecd.org/edu/.../Spain-TALIS-2013-secundarioweb%201-10-2014\\_es.pdf](https://www.oecd.org/edu/.../Spain-TALIS-2013-secundarioweb%201-10-2014_es.pdf), consultado el 23 de Noviembre de 2015.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423-435.
- Gopnik, A., & Melzoff, A. N. (1997). Words, thoughts and theories. Cambridge, MA: MIT Press.
- Ferrés, J. (2014). *Las pantallas y el cerebro emocional*. Barcelona: Editorial Gedisa.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London: Sage.
- Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76-85.
- Kirsh, D., & Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive Science*, 18(4), 513-549.
- Kordaki, M. (2013). High school computing teachers' beliefs and practices: A case study. *Computers & Education*, 68, 141-152.
- León, O. & Ruiz-Hernando, N. (2010). *Cómo afecta la forma de preguntar a los participantes. ¿Tiene sentido hablar del principio de indeterminación en Ciencias Sociales?* Unpublished manuscript. Autonomous University of Madrid.
- Liu, S. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers and Education*, 56, 1012-1022. doi:10.1016/j.compedu.2010.12.001
- López-Íñiguez, G. & Pozo, J.I. (2016) Analysis of constructive practice in instrumental music education: Case study with an expert cello teacher, *Teaching and Teacher Education*, 60, 97-107.
- Pérez-Echeverría, M. P., Mateos, M., Pozo, J. I., & Scheuer, N. (2001). En busca del constructivismo perdido: concepciones implícitas sobre el aprendizaje. *Estudios de psicología*, 22(2), 155-173.
- Pozo, J. I. (2008). *Aprendices y maestros: La psicología cognitiva del aprendizaje*. Madrid: Alianza Editorial.
- Pozo, J. I. (2014). *Psicología del Aprendizaje Humano: Adquisición de conocimiento y cambio personal*. Madrid: Morata.
- Pozo, J.I. & Postigo, Y. (2000). *Los procedimientos como contenidos escolares*. Barcelona: Edebé
- Pozo, J. I., Scheuer, N., Pérez Echeverría, M. del P., Mateos, M., Martín, E., & de la Cruz, M. (Eds.) (2006). *Nuevas formas de pensar la enseñanza y el aprendizaje. Las concepciones de profesores y alumnos*. Barcelona: Graó.
- Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*. 52: 302-312.
- Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education*, 36(2), 163-174.
- Voogt, J., & Knezek, G. (Eds.). (2008). *International handbook of information technology in primary and secondary education* (Vol. 20). Springer Science & Business Media.
- Wepner, S. B., Ziomek, N., & Tao L. (2003). Three teacher educators' perspectives about the shifting responsibilities of infusing technology into the curriculum. *Action in Teacher Education*, 24(4), 53-63.

## CAPÍTULO 9. CONCLUSIONES FINALES

---

Desde que las TIC irrumpieron en nuestra sociedad hace ya algunas décadas, los cambios y transformaciones se han sucedido de forma frenética y constante. Casi cualquier dimensión de nuestra realidad se ha visto de una u otra forma afectada por la introducción de esta tecnología, alterando concepciones tan básicas y encarnadas como la percepción del tiempo y el espacio.

La sociedad que emerge a raíz de ese movimiento continuo se hace y rehace en todo momento, renovando constantemente sus valores estéticos, políticos, culturales e intelectuales. Se trata de una sociedad líquida que al ser fotografiada siempre sale en movimiento.

Uno de sus bienes más preciados es la producción, gestión y comunicación de la información, hasta tal punto que gran parte de su estructura se ha vertebrado en torno a ese elemento. Basta simplemente con echar un rápido vistazo a las diferentes funciones que se demandan en los diversos puestos de trabajo o las cuestiones a las que dedicamos nuestro tiempo libre. La información es piedra angular en prácticamente todos los espacios.

Es tal la cantidad producida y tal la velocidad a la que cambia que ya no basta únicamente con apropiarse de ella. En la Sociedad del Conocimiento es imperativo dotarse de herramientas y recursos para evaluar críticamente la información, la calidad y fiabilidad de las fuentes y la capacidad para construir una opinión propia argumentada. Dialogar con la multiplicidad de voces que pueblan la red y asumir la responsabilidad de participar rigurosamente en esa construcción conjunta de conocimiento es pieza fundamental para nuestro pleno desarrollo como ciudadanos e individuos.

Ese proceso de formación de un nuevo individuo capaz de responder a las demandas y exigencias de la Sociedad del Conocimiento debe favorecer la articulación de una mente virtual estratégica capaz de navegar con rumbo por ese océano informativo. Para ello, nuestra acción debe ser orientada por metas epistémicas que nos permitan ir, desde los datos, más allá de los propios datos. Una acción que no se limite únicamente a la consecución y obtención de resultados positivos (p.ej. aprobar el examen de CC. Naturales), sino a comprender en profundidad la naturaleza del mundo que nos rodea (p.ej. ¿por qué el agua se evapora a partir de los 100°C?).

En este complejo e incierto contexto social, nuestros sistemas educativos deben adaptarse para hacer frente a esas nuevas demandas. Ya no es tiempo de ofrecer saberes y conocimientos herméticos, listos para un consumo rápido (y habitualmente de digestión lenta). Ahora es tiempo de utilizar esos contenidos como medio para desarrollar individuos competentes, capaces de desenvolverse de forma plena y autónoma en la sociedad actual.

Para lograr ese objetivo, no solamente se debe repensar las funciones y el sentido de nuestros sistemas educativos, debemos también repensar nuestra práctica y acción educativa. La coordinación y coherencia de los diferentes agentes involucrados es determinante para poder dar una respuesta efectiva.

Desde una mirada continuista y tradicional, las TIC no solamente se limitan a perpetuar prácticas obsoletas, sino que pueden convertirse en peligrosos instrumentos para nuestras formas de pensamiento y comportamiento. Ciberacoso, nuevas adicciones, o como ya alertaran algunos autores como Sartori (1998) o Simoni (2001), la pérdida de formas tradicionales de conocimiento basadas en la escritura y la reflexión, son sólo algunos de los riesgos que corremos al apropiarnos de las TIC de forma inadecuada.

Sin embargo, cuando su uso responde a una planificación meditada y pausada, con unos objetivos claros y precisos donde la construcción de un pensamiento crítico está en el centro de la agenda educativa, entonces las TIC se convierten en poderosos aliados para el desarrollo de un individuo más competente.

Las repercusiones que la introducción y expansión de las TIC tienen, y tendrán, sobre nuestra naturaleza humana sólo podrán juzgarse con precisión desde la distancia que nos dará el tiempo<sup>3</sup>. De nosotros depende que en el camino que nos queda por recorrer sean más y mejores los hallazgos que las pérdidas.

### Referencias

- Sartori, G. (1998). *Homo videns. La sociedad teledirigida*. Buenos Aires: Taurus
- Simoni, R. (2001). *La tercera fase. Formas de saber que estamos perdiendo*. Madrid: Taurus
- Cortina, A. y Serra, M.A. (2015). *¿Humanos o posthumanos? Singularidad tecnológica y mejoramiento humano*. Barcelona: Fragmenta Editorial

---

<sup>3</sup> Un intento por valorar las posibles consecuencias y predecir el futuro de nuestra especie es el interesante debate colectivo que se realizó a lo largo del año 2014 en el contexto de la edición online del periódico *La Vanguardia*, coordinado por Albert Cortina y Miquel-Àngel Serra y que se materializó en la publicación titulada “¿Humanos o Posthumanos? Singularidad tecnológica y mejoramiento humano” (Cortina y Serra, 2015)



## CHAPTER 9. FINAL CONCLUSIONS

---

Since ICT burst in our society few decades ago, we have experienced constant changes and transformations. Almost any dimension of our reality is affected by the introduction of this technology, altering deep conceptions such the perception of time and space. The emerging society makes and remakes itself every time, renewing its aesthetic, politics, cultural and intellectual values. It is a liquid society always in movement.

One of its most valuable elements concerns the production, management, and communication of information. We can be aware of it just watching the demands of the current jobs, or how we spend our free time. Information is a milestone everywhere.

However, in the Knowledge Society acquiring information is not enough. We need tools and resources to assess it critically, considering its quality and reliability in order to develop a justified opinion. We have to be able to dialogue with multiplicity of voices that shape the network and assume the responsibility to rigorously participate in the collective knowledge construction. In the Knowledge Society it is necessary to promote a virtual strategic mind capable to navigate in that informational ocean. In doing so, our action should be guided by epistemic goals that let us go beyond the information to knowledge. An action whose aim is not limited just to achieve positive results (e.g. pass the Science's exam) but oriented to deeply understand the nature of the world around us (e.g. why does the water boil at 100°C?).

In this complex and uncertain social context, the educational systems have the responsibility to adapt in order to effectively respond to the new challenges and demands. It is not the time to consume information and hermetic knowledge. It is the time to use contents as tools to develop aware, critical, and self-sufficient future citizens.

In order to achieve this goal, the educational systems have to rethink their functions and meanings, but also their practices and actions. The coordination and coherence between the agents involved are fundamental so that they can offer effective responses.

From a traditionalist point of view, ICT are used to perpetuate obsolete practices. Besides, they could become dangerous instruments for our thinking and behaviour. Some examples are cyberbullying, new addictions or, as authors like Sartori (1998) or Simoni (2001) already pointed out, the loss of traditional ways of knowledge based on writing and reflection.

However, when ICT are used under a structured plan, with clear aims and the construction of critical thinking as the priority, then this technology becomes a powerful alliance to develop more competent individuals.

We do not know yet the consequences of introduction and massive expansion of ICT in our human nature. We will be able to judge it just from the distance of time<sup>1</sup>. It is up to us that all those things we achieve were better than all those things we lose.

### References

- Sartori, G. (1998). *Homo videns. La sociedad teledirigida*. Buenos Aires: Taurus
- Simoni, R. (2001). *La tercera fase. Formas de saber que estamos perdiendo*. Madrid: Taurus
- Cortina, A. & Serra, M.A. (2015). *¿Humanos o posthumanos? Singularidad tecnológica y mejoramiento humano*. Barcelona: Fragmenta Editorial

---

<sup>1</sup> Albert Cortina and Miquel-Àngel Serra promoted an online discussion in 2014 where people debated about possible consequences of massive use of ICT in our human nature. See “*¿Humanos o posthumanos? Singularidad tecnológica y mejoramiento humano*” (Cortina & Serra, 2015)

# **SECCIÓN V**

---

## **ANEXOS**




ANEXO A-ESTUDIO I

---

ANEXO A1-Portada original artículo (Artículo I)

Article

# A Classification Framework for Exploring Technology-Enabled Practice–FrameTEP

Journal of Educational Computing Research  
0(0) 1–21  
© The Author(s) 2016  
Reprints and permissions:  
sagepub.com/journalsPermissions.nav  
DOI: 10.1177/0735633116636767  
jec.sagepub.com  


Sarah Prestridge<sup>1</sup> and Carlos de Aldama<sup>2</sup>

## Abstract

This article theorizes the construction of a classification framework to explore teachers' beliefs and pedagogical practices for the use of digital technologies in the classroom. There are currently many individual schemas and models that represent both developmental and divergent concepts associated with technology-enabled practice. This article draws from a depth of literature in this field to synthesize a classification framework used as an analytic tool to interpret technology-enabled practice. The framework was drawn from literature covering teachers' epistemic beliefs, pedagogical beliefs, pedagogical approaches, technological competency, and perceived levels of learning. It emerged as a result of the need to analysis case study data from a large-scale research project into the effective use of digital games in the classroom: *Serious Play: Digital Games, Learning and Literacy for Twenty First Century Schooling*. Yin suggests the use of a uniform framework to enable cross-case synthesis. The framework provides an analytical tool to help interpret why and how teachers are using, in this case, digital games in their classrooms. It also provides a significant contribution to the variances in technology-enabled practice along the traditional-constructivist continuum as well as to the relationship in how teacher beliefs direct pedagogical practice and choice of technologies used for learning.

---

<sup>1</sup>School of Education and Professional Studies, Griffith University, Brisbane, Queensland, Australia

<sup>2</sup>University Autonoma of Madrid, Ciudad Universitaria de Cantoblanco, Madrid, Spain

## Corresponding Author:

Sarah Prestridge, School of Education and Professional Studies, Mt Gravatt Campus, Griffith University, Brisbane, Queensland 4122, Australia.  
Email: s.prestridge@griffith.edu.au



ANEXO B-ESTUDIO II

---

ANEXO B1-Portada Original Artículo (Artículo II)



# How are ICT used in the classroom? A study of teachers' beliefs and uses

**Carlos de Aldama<sup>1</sup>, Juan Ignacio Pozo<sup>1</sup>**

---

<sup>1</sup>School of Psychology, Autonomous University of Madrid, Madrid

---

**Spain**

*Correspondence:* Carlos de Aldama Sánchez. School of Psychology, Autonomous University of Madrid, Cantoblanco University Campus, 28049, Madrid, Spain. Tel.: + 34 91 497 87 50. E-mail: [Carlos.dealdama@uam.es](mailto:Carlos.dealdama@uam.es)

---

© Education & Psychology I+D+i and Ilustre Colegio Oficial de la Psicología de Andalucía Oriental (Spain)





**ANEXO B2. Cuestionario Profesorado**

A continuación le vamos a realizar una serie de preguntas donde nos interesamos por sus concepciones en relación a las Tecnologías de la Información y la Comunicación (de ahora en adelante TIC) y su impacto educativo en los procesos de enseñanza y aprendizaje. La información es anónima y el uso de la misma exclusivamente con fines académicos. Muchas gracias por su colaboración.

**DATOS PERSONALES**

<p>1-Edad:</p> <p>2-Sexo:</p> <p>3-¿Qué estudios ha cursado?</p> <p>4-Colegio en el que trabaja actualmente:</p> <p>5-¿Cuántos años hace que se dedica a la docencia?:</p> <p>6-¿Qué materias imparte actualmente y en qué cursos?:</p> <p>7-¿Utiliza las TIC en el contexto de las asignaturas que imparte? ¿En cuáles?:</p>	<p>8-¿Con qué frecuencia las utiliza? (indique la frecuencia de uso en relación a cada una de las asignaturas):</p> <table border="1"> <thead> <tr> <th>Materia</th> <th>Diaria-mente</th> <th>Semanal-mente</th> <th>Mensual-mente</th> <th>Anual-mente</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>9-¿Cuántos años hace que utiliza las TIC en el contexto educativo?:</p> <p>10-¿Utiliza las TIC en el contexto educativo por voluntad propia o porque son las directrices del centro?</p> <p>11-¿Qué tipo de tecnologías utiliza en el contexto de la/s materia/s que impartes (tanto hardware como software)?</p>	Materia	Diaria-mente	Semanal-mente	Mensual-mente	Anual-mente															
Materia	Diaria-mente	Semanal-mente	Mensual-mente	Anual-mente																	

1-Según su opinión, ¿cree que el impacto provocado por las TIC está cambiando las formas de enseñar y aprender? En caso afirmativo, ¿de qué manera lo están haciendo?

2-A continuación describa los 3 usos de las TIC que considere más importante en el contexto de alguna de las asignaturas que imparta (escoja usted mismo las materias deseadas), atendiendo a los criterios que le proponemos a continuación:

Actividad 1

*Materia y curso:*

*Descripción:*

*Rol desempeñado por el docente y los alumnos:*

*Objetivo de aprendizaje deseado:*

*Posibles problemas de aprendizaje que puedan surgir en sus alumnos y su reacción como docente frente a los mismos:*

Actividad 2

*Materia y curso:*

*Descripción:*

*Rol desempeñado por el docente y los alumnos:*

*Objetivo de aprendizaje deseado:*

*Posibles problemas de aprendizaje que puedan surgir en sus alumnos y su reacción como docente frente a los mismos:*

Actividad 3

*Materia y curso:*

*Descripción:*

*Rol desempeñado por el docente y los alumnos:*

*Objetivo de aprendizaje deseado:*

*Posibles problemas de aprendizaje que puedan surgir en sus alumnos y su reacción como docente frente a los mismos:*

¡Muchas gracias por su colaboración!

**ANEXO C-ESTUDIO III**

---

**ANEXO C1-Artículo III**

*Anexo C1.1-Categorías de análisis*

**C1.1.1. MATRIZ GENERAL DE ANÁLISIS:**

Ciclo	Descripción	Actividad	Uso de las TIC	Alumno		Docente		Interacción		
				Demanda	Exigencia Cognitiva	Ayuda Pedagógica	Exigencia Cognitiva	Estructura Participación	Participantes y Nivel de Participación	Grado de Apertura (Inicial-Final)

## Anexo C1.1. Categorías de análisis

### C1.1.2. USO DE LAS TIC:

USOS DE LAS TIC											
Gestión Info						Producir Material					
Acceso Info: Seguir instrucciones para recuperar info determinada		Búsqueda: Indagar con el objetivo de encontrar la información deseada			Contraste fuentes: comparar más de una información	Publicar: subir un material a internet y compartirlo	Crear: Elaborar un material mediado por las TIC		Presentar: transmitir una información	Transferir conocimiento: Poner en práctica un conocimiento aprendido previamente	Argumentar: Dar razones que justifiquen un determinado planteamiento
Usos TIC  Actvs		Factual	Conceptual	Procedimental			A través de Software Específico	Sin Especificar			

**C1.1.3. DEMANDA DEL ALUMNO:**

		Contenido de la Tarea			Gestión/ Organización de la Tarea	
		Factual: Datos	Conceptual: Relación entre datos	Procedimental: cómo hacer algo, instrucciones	Gestión Metacognitiva	Otros
PREGUNTAS DE LOS ALUMNOS	<i>Confirmación:</i> Se formula una pregunta para buscar aprobación					
	<i>Pedir/ Solicitar:</i> Se formula una pregunta para demandar instrucciones, órdenes o aclaración que permitan continuar con la tarea					
	<i>Dudar:</i> Se muestra indeciso entre dos o más opciones					
AFIRMACIÓN: Es una intervención de los alumnos donde se busca la aprobación/ intervención/ sugerencia... del docente						

Anexo C1.1. Categorías de análisis

**C1.1.4. AYUDAS PEDAGÓGICAS DEL DOCENTE:**

		Contenido Tarea			Gestión/ Organización de la Tarea	
		Factual	Conceptual	Procedimental	Gestión Metacognitiva	Actitud/ Valores
AYUDAS PEDAGÓGICAS DEL DOCENTE	Preguntar					
	Corroborar					
	Informar	Dar datos	Definiciones/ Conceptos, etc, pero sin saber exactamente si ayuda a establecer relaciones conceptuales			
	Explicar					
	Dar instrucción					
	Guiar	Sin andamiaje				
		Con Andamiaje				
	Corregir					



#### C1.1.5. EXIGENCIA COGNITIVA:

Adquisición	Interpretación	Análisis	Comprensión y Organización	Comunicación

#### C1.1.5. ESTRUCTURA DE PARTICIPACIÓN:

*Ciclos Cortos (CC):* Aquellos que suponen pocos intercambios hasta que finaliza el ciclo (2-3 intercambios máximo)

*Ciclos Largos (CL):* Aquellos que suponen numerosos intercambios hasta que finaliza el ciclo (a partir de 3 intercambios). Son verdaderas experiencias comunicativas

#### C1.1.6. PARTICIPANTES Y NIVEL DE PARTICIPACIÓN:

Hace referencia a quién interviene y de qué manera en el ciclo en relación con la *Planificación de la Tarea* (¿quién resuelve la tarea?) y en relación con la *Supervisión* (¿quién evalúa la tarea?):

PA-PA → Ambos procesos dependen tanto de profesor como alumno

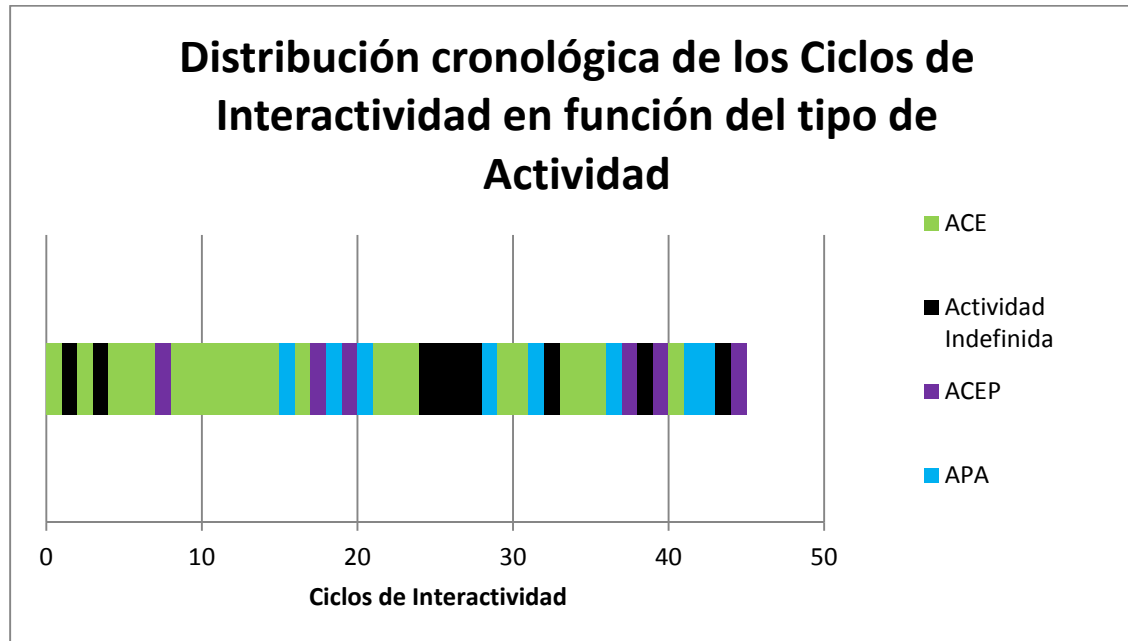
A-A → Ambos procesos dependen sólo del alumno

P-P → Ambos procesos dependen sólo del profesor

**C1.1.7. GRADO DE APERTURA DE LA INTERACCIÓN (INICIAL-FINAL)**

Hace referencia al grado de apertura con que se inicia y se finaliza la interacción. Pueden ser Abiertas (A) cuando existen múltiples posibilidades y amplio margen de acción y Cerrado (C) en el caso contrario. Así, las diferentes posibilidades serían: A-A, A-C, C-A, C-C

## C1.2. DISTRIBUCIÓN CRONOLÓGICA DE LOS CICLOS COMUNICATIVOS



Aunque es cierto que esta gráfica representa los Ciclos desde el punto de vista de Jose, parece que existe una tendencia de los alumnos a responder inicialmente preguntas más sencillas para posteriormente resolver las más complejas.



## ANEXO C2. Artículo IV

### *Anexo C2.1. Acuerdo Cesión Derechos*

**Work:** SAGE Research Methods Cases - Education  
**Contribution:** Analysis of Content: ICT Integration in Higher Education

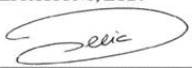
**CONTRIBUTOR**

Signed By: Carlos de Aldama  
de Aldama, Carlos

Date: 4/18/2016 2:29:25 AM

**Editor:** Flett, Bronia

**SAGE PUBLICATIONS, LTD.**

Signed By:   
Delia Martinez-Alfonso, Publisher



## ANEXO D-ESTUDIO IV

## ANEXO D1. CUESTIONARIO USOS DE LAS TIC PARA LOS ALUMNOS



Fecha:

A continuación te vamos a realizar una serie de preguntas relacionadas con tu experiencia con los ordenadores, los videojuegos e internet. No existen respuestas correctas o incorrectas, únicamente debes responder de forma sincera. La primera hoja rellénala en la hoja de respuestas y la segunda directamente sobre el papel. ¡Muchas gracias por tu colaboración!

1-Nombre y Apellidos:

2-Fecha de nacimiento:

3-¿Qué grado de conocimiento tienes sobre las siguientes tareas relacionadas con el uso de ordenadores y conexión a internet? (marca en hoja de respuesta)

No sé lo que es/ significa	Sé lo que es pero no sé hacerlo	Puedo hacerlo pero con la ayuda de alguien	Puedo hacerlo yo solo
-------------------------------	------------------------------------	---	--------------------------------

1-Abrir un archivo o documento	A	B	C	D
2-Imprimir un documento	A	B	C	D
3-Instalar / desinstalar un programa	A	B	C	D
4-Crear un documento de texto (Word o similares)	A	B	C	D
5-Crear una presentación (PowerPoint o similares)	A	B	C	D
6-Crear una hoja de cálculo (Excel o similares)	A	B	C	D
7-Crear una base de datos (Acces o similares)	A	B	C	D
8-Utilizar un buscador de Internet para buscar información	A	B	C	D
9-Descargar un archivo de internet	A	B	C	D

## Anexo D1. Cuestionario Usos de las TIC para los alumnos

10-Enviar un correo electrónico	A	B	C	D
11-Adjuntar un archivo en un correo electrónico	A	B	C	D
12-Utilizar un programa de mensajería instantánea	A	B	C	D
13-Publicar contenidos en Internet	A	B	C	D
14-Diseñar o modificar páginas webs o blogs	A	B	C	D



4-¿Qué tipo de usos y con qué frecuencia sueles utilizar el ordenador e Internet? (marca en hoja de respuesta)

	Nunca	Menos de una vez al mes	Dos o tres veces al mes	Dos o tres veces a la semana	Todos o casi todos los días
15-Buscar información que necesito para trabajos de mis asignaturas	A	B	C	D	E
16-Colaborar con otros compañeros para hacer trabajos de mis asignaturas	A	B	C	D	E
17-Enviar preguntas o recibir respuestas de mis profesores	A	B	C	D	E
18-Preparar trabajos o hacer los deberes con un ordenador	A	B	C	D	E
19-Comunicarme con amigos o familiares	A	B	C	D	E
20-Participar en foros o debates que me interesan	A	B	C	D	E
21-Buscar información sobre temas que me interesan	A	B	C	D	E
22-Leer documentos en red (periódicos, revistas digitales, blogs, etc)	A	B	C	D	E
23-Escuchar programas de radio o podcats	A	B	C	D	E
24-Compartir fotos, videos u otro tipo de archivos que yo mismo he creado	A	B	C	D	E
25-Bajarme música, películas, juegos u otros programas	A	B	C	D	E
26-Jugar a videojuegos	A	B	C	D	E

5-¿En qué medida estás de acuerdo con las siguientes afirmaciones? (marca en hoja de respuesta):

	Muy en desacuerdo	Bastante en desacuerdo	Ni en acuerdo ni en desacuerdo	Bastante de acuerdo	Muy de acuerdo
27-Me interesa mucho todo lo relacionado con ordenadores e Internet	A	B	C	D	E
28-Con Internet he podido conocer a nuevos amigos y amigas	A	B	C	D	E
29-Utilizar Internet es muy fácil	A	B	C	D	E
30-A mis padres no les gusta que yo navegue por Internet	A	B	C	D	E
31-En Internet casi siempre encuentro la información que necesito	A	B	C	D	E
32-Con Internet me resulta más fácil hacer los deberes	A	B	C	D	E
33-Desde que utilizo Internet saco mejores notas	A	B	C	D	E
34-Con los ordenadores y con Internet se aprende mejor	A	B	C	D	E
35-La mayoría de las cosas que hacemos en clase con los ordenadores y con Internet se podrían hacer igualmente si no lo tuviéramos	A	B	C	D	E
36-Saber utilizar bien Internet y los ordenadores me será imprescindible	A	B	C	D	E

## Anexo D1. Cuestionario Usos de las TIC para los alumnos

para poder continuar estudiando y en el futuro poder encontrar trabajo.      A      B      C      D      E

6-En caso de que juegues a videojuegos (ya sea con ordenador, videoconsola, Smartphone, etc), ¿cuáles son los que más te gustan? (Rellena las casillas que necesites):

NOMBRE DEL VIDEOJUEGO	TEMÁTICA	FRECUENCIA DE USO
	A-Acción      D-Luchas B-Aventuras    E-Carreras C-Estrategia    F-Otros (especificar) D-Luchas	
1-		1-Nunca
2-		2- Menos de una vez al mes
3-		3-Dos o tres veces por al mes
4-		4- Dos o tres veces a la semana
		5-Todos o casi todos los días

7-¿Has aprendido algo con el uso de los videojuegos? (Rellena las casillas que necesites):

NOMBRE DEL VIDEOJUEGO	¿QUÉ HAS APRENDIDO?	IMPORTANCIA (enumera del 0 al 5, donde 0 es “nada importante” y 5 es “muy importante”)
1-		
2-		
3-		
4-		
5-		

8-¿Crees que has aprendido algo de **Física y Química** gracias al uso de los videojuegos? (Rellena las casillas que necesites):

NOMBRE DEL VIDEOJUEGO	¿QUÉ HAS APRENDIDO?	IMPORTANCIA (enumera del 0 al 5, donde 0 es “nada importante” y 5 es “muy importante”)
1-		
2-		

## Anexo D1. Cuestionario Usos de las TIC para los alumnos

3-		
4-		
5-		

9-¿Con qué dispositivos cuentas en tu casa? (marca con una X):

-Videoconsola (Play Station, Xbox, Wii, etc)    -Tablet (iPad, Samsung Tab, etc)

-Ordenador de sobremesa

-Smartphone (iPhone, Samsung Galaxy)

-Ordenador portátil

-Otros (Especificar):

10-¿En qué medida conoces el videojuego Angry Birds? (marca con una X):

10.1-No lo conozco

10.2-Lo conozco, pero no he jugado nunca

10.3-Apenas he jugado unas pocas veces

10.4-Antes jugaba con frecuencia (aproximadamente 3-4 veces por semana), pero en la actualidad ya no

10.5-Actualmente juego de manera regular (aproximadamente 3-4 veces por semana)

10.6-Juego todos los días

¡Ya hemos terminado, gracias por tu colaboración!

## ANEXO D.2.PRUEBA DE EVALUACIÓN DEL CONOCIMIENTO DE LOS ALUMNOS SOBRE EL MOVIMIENTO DE OBJETOS

Nombre:

Grupo:

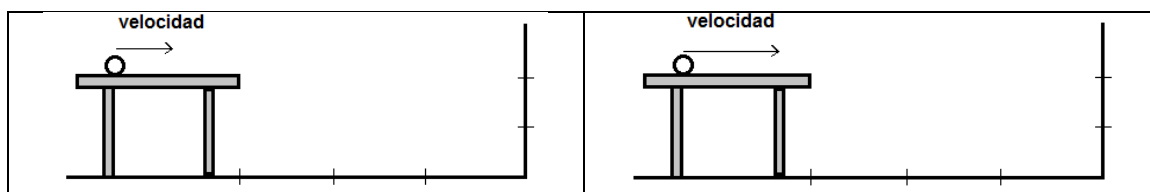
Centro escolar:

Fecha:

### Cuestionario (F-5)

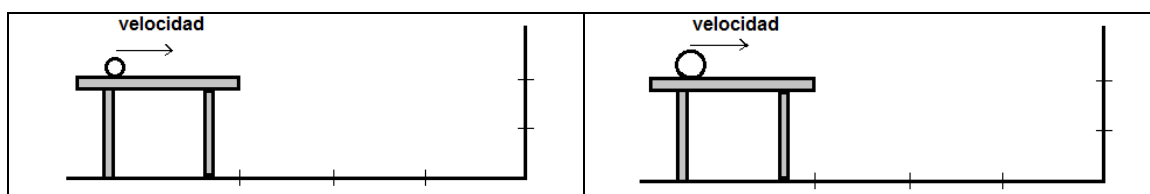
1.- En los siguientes dibujos se muestra una mesa con el suelo donde está apoyada y una pared. La pelota rueda por una mesa con una determinada velocidad cuyo valor viene determinado por el tamaño de la flecha (en el segundo caso va el doble de rápido que en el primero. Cuando llega al final de la mesa, ¿Qué crees que pasará?

**Dibuja la línea que representa la trayectoria que crees que seguirá la pelota y el punto en el que choca con el suelo o la pared.**



2.- Realizamos ahora la misma experiencia con dos pelotas de distinta masa que ruedan con la misma velocidad. Cuando llega al final de la mesa, ¿Qué crees que pasará?

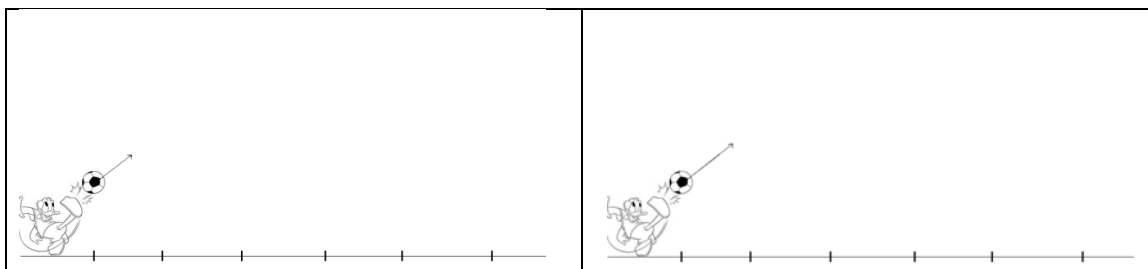
**Dibuja la línea que representa la trayectoria que crees que seguirá la pelota y el punto en el que choca con el suelo o la pared.**



3.- En un campo de futbol, un jugador lanza un balón, con distinta velocidad en cada caso (la velocidad viene dada por la longitud de la flecha) ¿Qué crees que pasará?

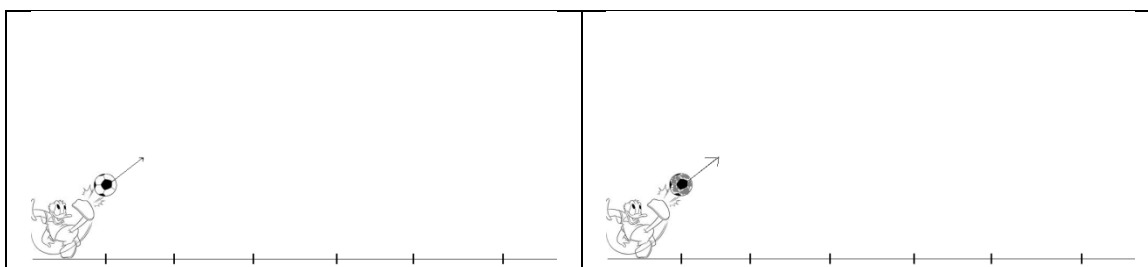
**Dibuja la línea que representa la trayectoria que crees que seguirá el balón, en cada caso.**

Anexo D2. Prueba de evaluación del conocimiento de los alumnos sobre el movimiento de objetos



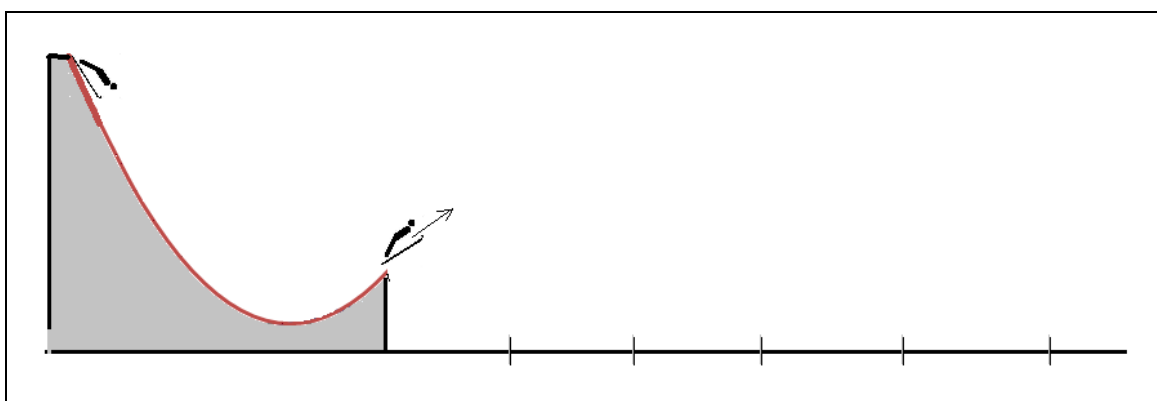
4.- El mismo jugador repite ahora los lanzamientos con dos balones distintos y la misma velocidad en los dos casos. El primer balón es normal, igual que en la pregunta anterior, el segundo balón (más oscuro), es igual pero va relleno de arena.) ¿Qué crees que pasará?

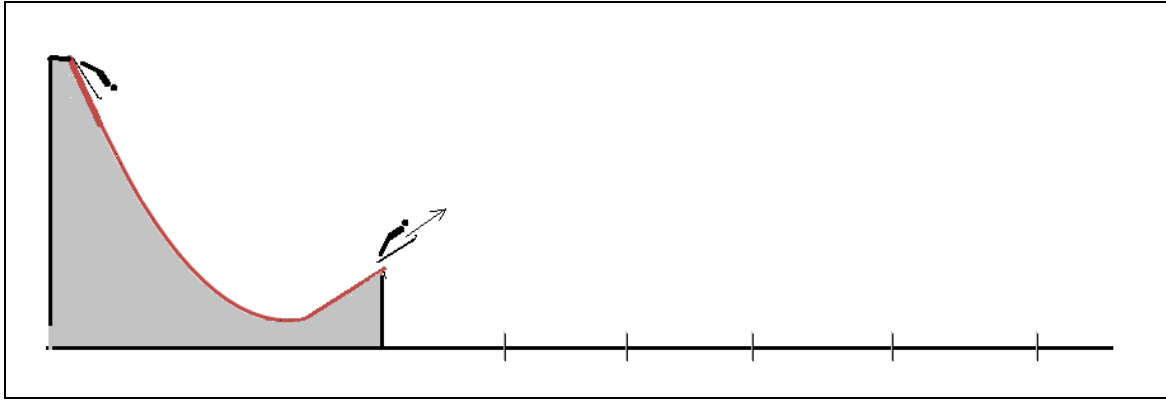
**Dibuja la línea que representa la trayectoria que crees que seguirá el balón, en cada caso.**



5.- En un concurso de saltos de esquí están probando dos tipos de pistas de lanzamiento. La primera acaba en una rampa curva y la segunda en una rampa recta. En los dos casos el saltador cae desde la **misma altura** y sale con el **mismo ángulo** de la pista de lanzamiento. ¿Cómo crees que se comportará cada pista?

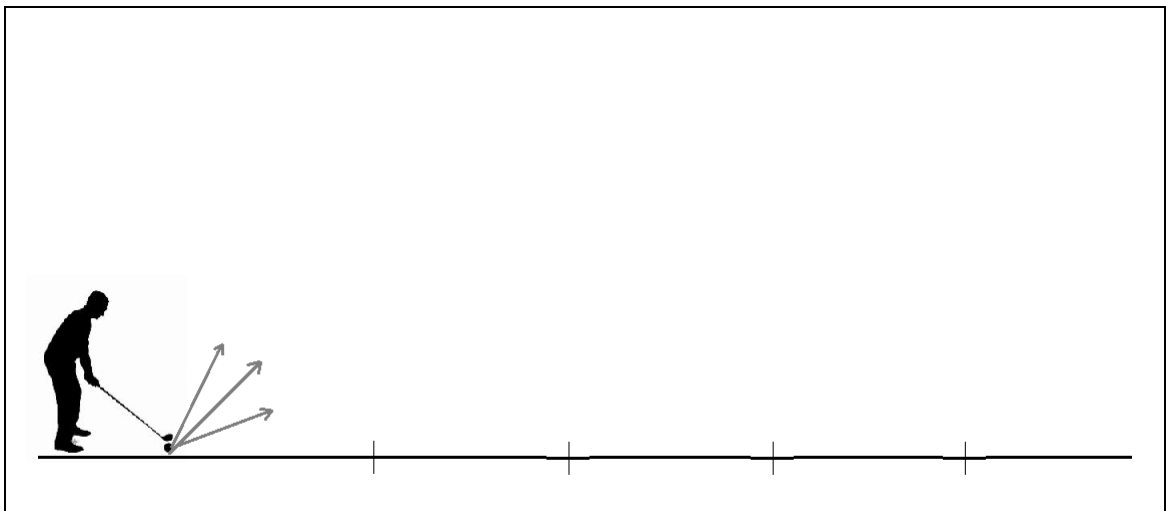
**Dibuja la línea que representa la trayectoria que crees que seguirá el esquiador, en cada caso.**



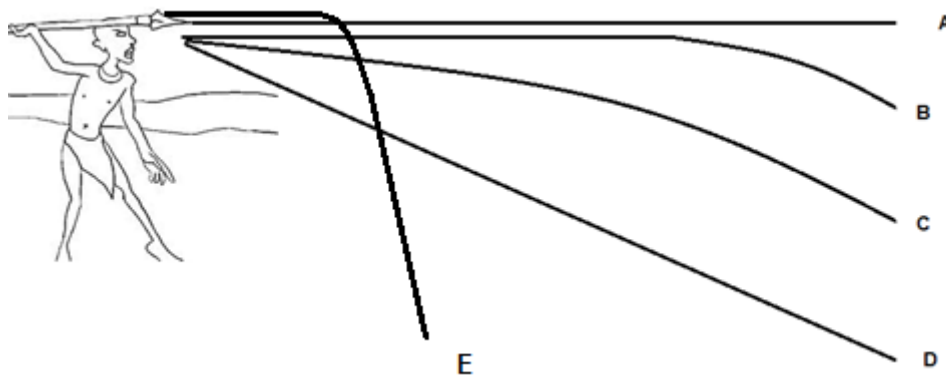


6.- Un jugador de golf está ensayando diversas jugadas. En este caso hace tres lanzamientos en los que golpea la pelota siempre con la misma fuerza, pero la lanza con tres ángulos distintos ( $30^\circ$ ,  $45^\circ$  y  $60^\circ$ ). ¿Cómo crees que se moverá la pelota?

**Dibuja la línea que representa la trayectoria que crees que seguirá la pelota, en cada caso.**



7.- Un cazador utiliza una lanza para matar a sus presas. En un determinado momento, lanza con fuerza su arma horizontalmente.

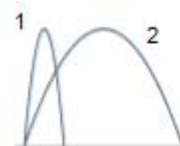


Anexo D2. Prueba de evaluación del conocimiento de los alumnos sobre el movimiento de objetos

En el dibujo anterior, qué línea crees que representa más aproximadamente la trayectoria seguida por la lanza.

- a) A    b) B    c) C    d) D    e) E

8.- La figura nos muestra la trayectoria de dos piedras lanzadas al aire. ¿En qué caso crees que ha estado la piedra más tiempo en el aire?



- a) En 1.                  B) En 2.                  C) en los dos casos ha estado el mismo tiempo.  
d) No puede saberse sólo con ese dibujo.

9.- La figura nos muestra la trayectoria de dos piedras lanzadas al aire. ¿En qué caso crees que ha estado la piedra más tiempo en el aire?

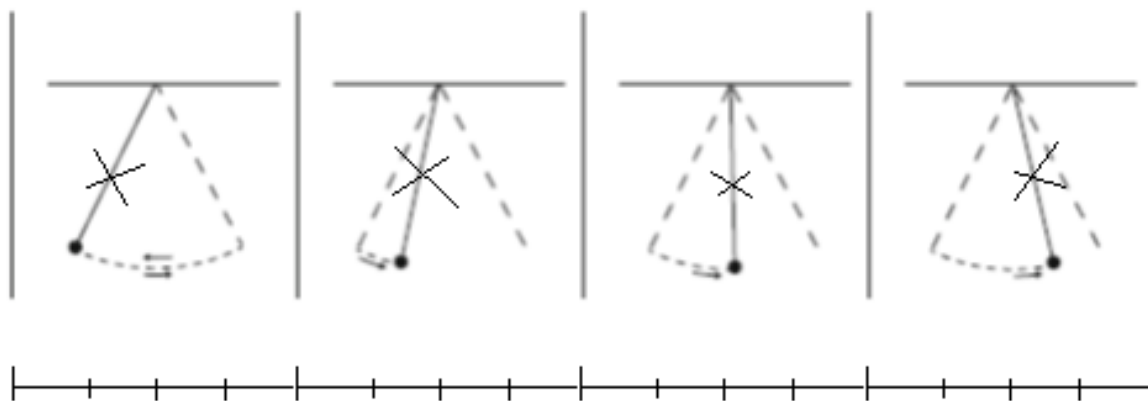


- a) En 1.                  B) En 2.                  C) en los dos casos ha estado el mismo tiempo.  
d) No puede saberse sólo con ese dibujo.

10.- El dibujo muestra a trayectoria de una moneda de 5 céntimos que hemos lanzado al aire. Si lanzamos ahora una moneda de 2 €, exactamente de la misma manera, qué crees que pasará. Añade sobre el dibujo una línea que indique la trayectoria seguida, en tu opinión.

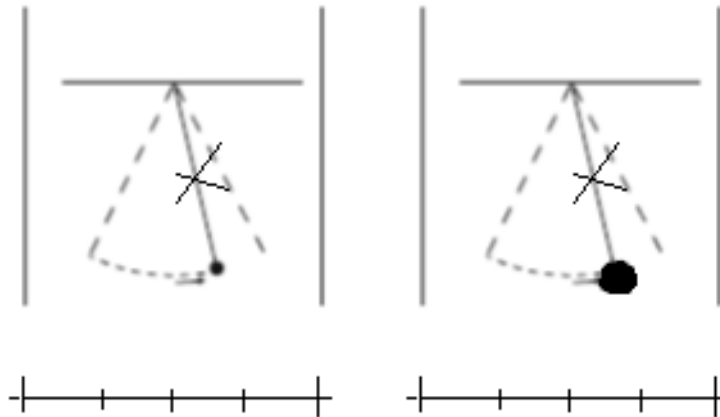


11-14.- Los dibujos te muestran el movimiento de un péndulo que va y viene, en un plano. Cada uno de los dibujos muestra un instante en el movimiento de ese péndulo. En ese momento se corta la cuerda, ¿Cómo crees que caerá la bola, qué trayectoria seguirá? **Dibuja el movimiento de la bola en cada uno de los cuatro casos.**



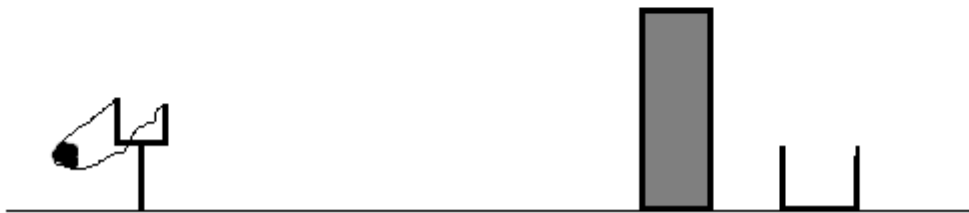


**15.-** ¿Qué diferencia hay si la bola del péndulo es más pesada en un caso que en otro? Dibuja la trayectoria que seguiría la bola cuando se corta la cuerda.



EXPLICA LA RESPUESTA:

**16.-** El dibujo te muestra un tirachinas (a la izquierda) y una caja (a la derecha), con una barrera en medio. Tienes que conseguir meter una piedra en la caja lanzándola con el tirachinas. Dibuja cómo crees que tendría que moverse la piedra para conseguirlo.



**17.-** Si tuvieras que ayudar a alguien a meter la piedra en la caja utilizando el tirachinas que instrucciones deberías darle para ayudarlo a conseguirlo.

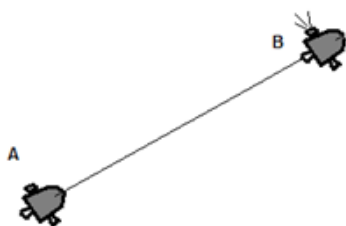
Anexo D2. Prueba de evaluación del conocimiento de los alumnos sobre el movimiento de objetos

**18.-** Si tuvieras que explicarle a un compañero cuál es la mejor forma de lanzar una piedra para conseguir que llegue lo más lejos posible, ¿qué instrucciones le darías?

19.- Desde un puente de 25 m de altura lanzamos horizontalmente una piedra con velocidad de 30 m/s. Calcula:

- a) ¿A qué distancia de la base del puente llega al suelo?.
- b) Velocidad con la que llega al suelo.

20.- Una nave espacial se mueve por el espacio exterior, en ausencia de gravedad, con los motores apagados. Se desplaza desde A hasta B siguiendo una línea recta con velocidad constante. En el instante en que pasa por el punto B enciende uno de los tres pequeños motores (reactores) con los que va equipada (el que vemos en la parte de más arriba de la imagen). Dibuja la trayectoria que crees que seguirá la nave mientras tiene encendido el motor.



21.- Durante el tiempo que has estado trabajando el tiro parabólico en el instituto, ¿con que frecuencia has jugado al Angry Birds? (piensa en el día a día, dentro y fuera del instituto).

- a) Nada
- b) Apenas he jugado
- c) He jugado bastante
- d) He jugado mucho

¡MUCHAS GRACIAS!

Anexo D2. Prueba de evaluación del conocimiento de los alumnos sobre el movimiento de  
objetos

